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Conducted by MAJOR B. BADEN-POWELL, F.R.A.S., F.R.Met.Soc., and E. S. GREW, M.A.

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Palaeozoic Rocks Under South-Eastern England.

By EDWARD A. MARTIN, F.G.S.

THE problem as to the contour of the palæozoic rocks under the newer formations of the south of England still remains in many respects unsolved, and only by the labours of many workers, and by the expenditure of much time and money, do we now and again advance a step in the solution of the problem. When coal-measures were reached at Shakespeare's Cliff in 1892, at a depth of 1,157 feet, it was felt that a great advance in underground exploration had been made, since it proved that the palæozoic floor had here risen, on the east, from a great unknown depth at Netherfield, farther west, where the boring commenced in 1872 had fallen short of 2,000 feet, and yet had not pierced the Kimmeridge Clay. In a north-westerly direction from Netherfield, and on the opposite side of the Weald, a more recent boring at Penshurst did not leave the Wealden Beds until 1,500 feet had been reached, and this one terminated in Kimmeridge Clay at 1,867 feet. It seems probable that a line drawn between Penshurst and the coast at about Hastings represents the position of the greatest thickness of the deposits laid down in the ancient Wealden estuary, and it is safe to say that in future the portion of the Weald represented by this line will be severely left alone in any attempt to touch the primary rocks.

On the east, from this imaginary line (see Fig. No. 1), the evidence points to a rise of the base of the Wealden, and at Pluckley (west of Ashford) these beds have become reduced to a thickness of 915 feet, the base of the Kimmeridge Clay being found at 1,397 feet.

Going still further east, on the farther side of Ashford, we find that at Brabourne the base of the Wealden has risen to 675 feet, whilst the whole of the Jurassic series was passed through, and the Lias reached, at 1,664 feet (see Fig. No. 2). Passing thence eastward on to the chalk, coal-measures have been reached at Ropersole and Dover, there being at the former place only 55 feet of Wealden, at the Dover Convict Prison only 82 feet, and at Dover Colliery but 94 feet. The thinning is therefore rapid on the east.

Westward from Penshurst, there is a lack of borings which would show the thickness of the Wealden Beds. Right away to the west, however, beyond the chalk of

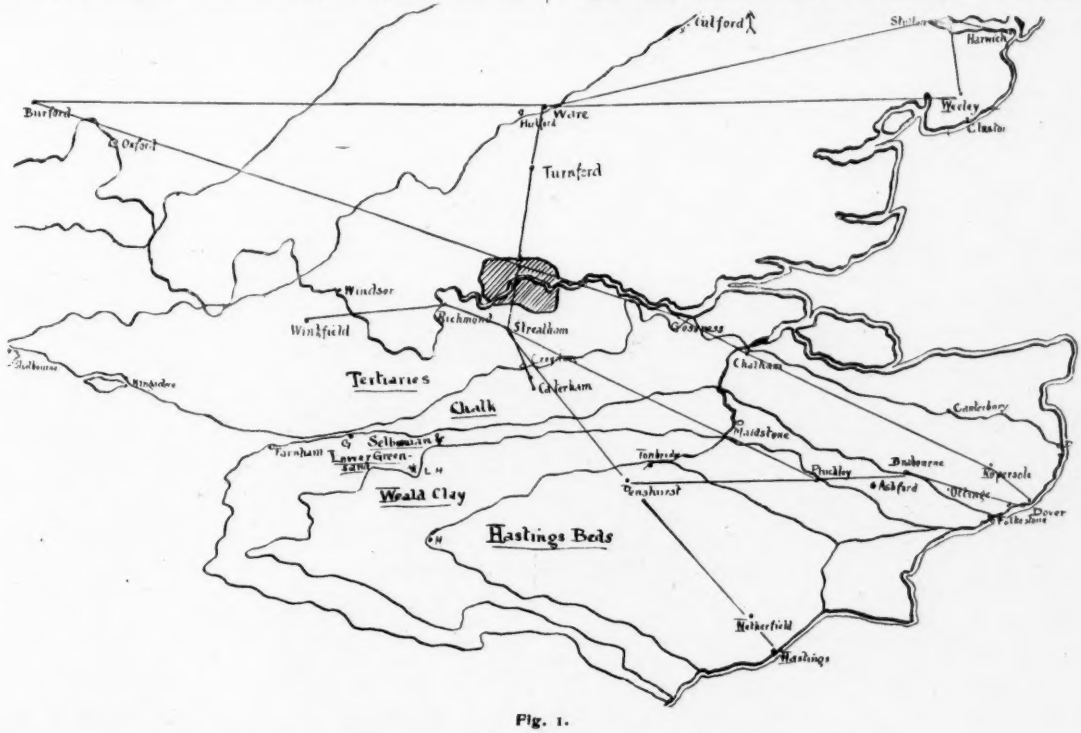


Fig. 1.

Wiltshire, we know that the Jurassic rocks rise from beneath the cretaceous series, but there is no Wealden outcrop between them. Thus, the Wealden has entirely thinned out in this direction. If the thinning west of Penshurst were at all to resemble that to the east of it, we should look to the neighbourhood of Farnham as the site of its final disappearance underground.

Of evidence of the loss of the Wealden in a northerly direction from the axis of the Weald, there is plenty. As we have seen, at Penshurst there is 1,500 feet of this formation, but north-north-west thence, at Streatham, there is none. In about 20 miles this great thickness of strata has thinned away to nothing. At Richmond, no Wealden were found, about 16 miles north from its nearest outcrop. At Crossness it was the same, only 18 miles from the outcrop; and also at Chatham Dockyard, only 13 miles from the main outcrop.

With this thinning out, the primary rocks appear

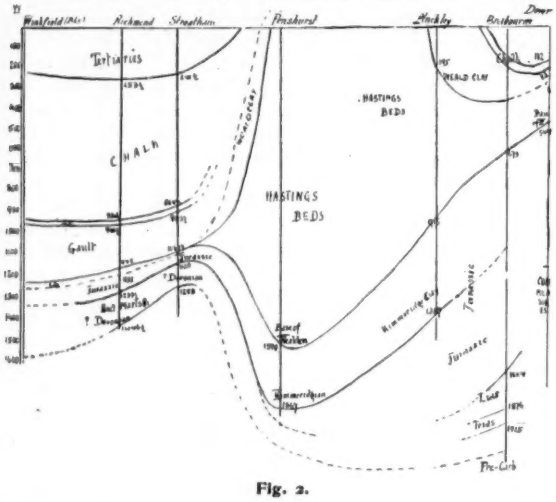


Fig. 2.

therefore to rise rapidly as we approach the Thames Valley. This is shown by the deeper-seated of the borings.

At Richmond, "marls, sandstones, clay," etc., were met with at 1,239½ feet. At Streatham, "grey, reddish, and purplish beds" were met with at 1,120 feet. At Crossness undoubted Devonian rocks were found at 1,008 feet, and although the rocks in two of these three borings are of somewhat doubtful age, geologists are, in general, of opinion that they may be of Old Red age. If this be so, we have here on the north passed on to that portion of the primary or palæozoic land-surface which is made up of rocks older than the coal-measures, and if coal be the object in view, we should have to make our search somewhat farther south, perhaps just south of the escarpment of the North Downs.

Beyond the Thames, rocks of Upper Devonian age have been found, at Tottenham Court Road at 1,066 feet, and at Turnford (Cheshunt) at 980½ feet, while eight miles further north still older rocks rise even nearer to the surface at Ware, Silurians being encountered here at 795 feet.

West from Ware, Burford has yielded carboniferous rocks at 1,184 feet, and eastward thence, pre-carboniferous rocks have been found at Stutton, Weeley, and Harwich, all of which demonstrate the rise in a northerly direction of the ancient land surface.

Southward, we see the old land swoop down under the Thames Basin, forming possibly a northern bank which prevented the Wealden estuary from extending in that direction. Thence it sinks deep down under the Wealden formation of Sussex, but not in Kent to so great an extent.

In Hants and Wilts, it will no doubt in course of time be found rising nearer the surface, but in the meantime it has only been traced with certainty under the chalk of Kent, and the discoveries of it on the south side of the Thames show that the line of the North Downs roughly indicates where it may best in the future be met with. Much of the interest felt in the search for this old-world surface has, as is well known, resulted from the desire to find an additional supply of coal from the south of England. That the buried surface is continuous from the Continent to England beneath the Channel is an undoubted fact, and Fig. No. 3 will bring this vividly before one's mind, for in this all the places where carboniferous rocks have been met with have been marked, the hiatus between the Somerset and the Calais coal-fields being shown by a dotted line. In this connection a few remarks by Prestwich will be useful, although other geologists have expressed similar views on subsequent occasions.

"A glance at the geological map of Europe will show that the Belgian coal-field is but a part of a series of great coal-fields ranging from Westphalia to the North of France. These coal-fields are deep, long, and narrow, and their longer axes succeed one another on the same line of strike. . . . Connected with these coal-fields, a great line of disturbance affecting the palæozoic rocks has been traced from Westphalia through Belgium to Northern France; and it is on the northern flanks of the older rocks of the Ardennes range of hills, which have been formed by this disturbance, that the coal-fields of Belgium lie. The *same* line of disturbance is again exhibited in the Mendips, and is prolonged even as far as the South of Ireland. The coal-measures of South Wales are not covered by secondary strata, but a large portion of the Somersetshire coal-measures are overlaid by some of the newer secondary rocks, which in their turn pass a few miles to the eastward under the chalk. . . . There can, however, be little doubt of the continuity of the range of the palæozoic rocks under these newer formations from Belgium to Somerset; but whether or no the coal-measures were ever continuous between the two districts, and whether, if they were, they have been removed by denudation, leaving only the lower palæozoic rocks, requires further discussion."

An interesting fact came to light in connection with the Richmond boring, and this was that when the junction beds both above and below the Great Oolite (Jurassic) were being deposited, coal-measures were near at hand suffering denudation, for in these beds numerous small fragments of anthracite coal were found to have been imbedded. It is thus extremely probable that not very far south a broad outcrop of carboniferous rocks lies buried, and amongst the various beds of the outcrop there would be undoubtedly coal-measures. Beside the anthracite fragments, many pebbles of coal-measure sandstone were also found.

Marked on the outline map will be found the sites of the various deep borings which have been made in the south-east of England. It will be seen, too, that certain of these may be united by fairly direct lines, and when this is the case the borings on these lines

may well be considered together, with a view to reconstructing the underground surface which existed at the close of the palæozoic period.

Thus from Burford, in Oxfordshire, where coal-measures have been met with at a depth of 1,184 feet, we may pass easterly to Ware, where Silurians have risen to 796½ feet, and on to Stutton and Harwich, where primary rocks of pre-carboniferous age have been reached. At Weeley, also, rocks of an unknown primary age have been bored into. At Ware and Culford, these ancient rocks have risen to a point which is nearer the surface there than the bottom of the chalk itself under London.

their existence has not yet been proved in those places. South from Caterham, as we have seen, the Wealden not only outcrops at the surface, but its base sinks to a profound depth, and, consequently also, all the ancient rocks which are beneath it. This will be seen illustrated in diagram No. 2. The borings shown thereon are not so clearly in one direction as those in previous diagrams, but they show decisively one point, namely, that in Sussex and West Kent, at all events, no future coal-fields are likely to be opened up. On the other hand, it shows the rapid thinning of the Wealden towards Dover, and the remarkable rise of primary rocks (coal-measures). In the more recent

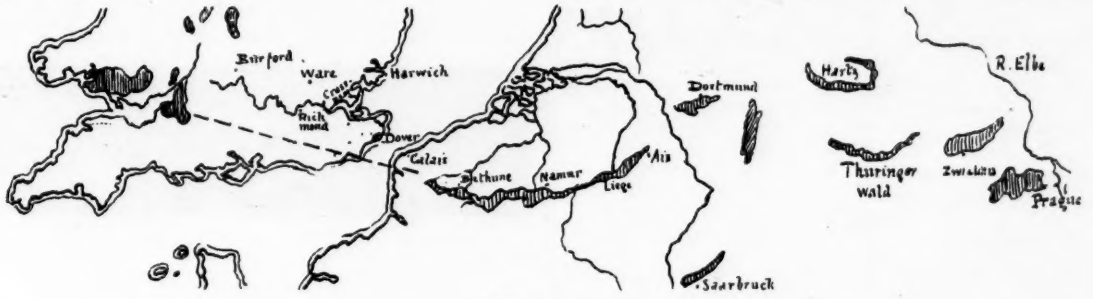


Fig. 3.

Another line of borings which may be considered together is that which connects Ware with Caterham, in Surrey, and passes across London. This set of borings is shown in Fig. No. 4, and illustrates a remarkable bending of the chalk upwards beneath the Thames Basin. In this it probably follows a similar folding of more ancient beds beneath it. The surface of the Devonian will probably present some such appearance as that shown in the diagram. The Devonian is not likely, however, to have been closely conformable with the superimposed gault clay. The old surface was, no doubt, one on which other members of the primary rocks showed their outcrops, and on which the forces of denudation had swept before that great era came to a close. In order to illustrate this probability, I have shown carboniferous rocks, with a query before the word where introduced, as, of course, boring at Ropersole, the Wealden had decreased to 55 feet in thickness.

When we come to consider the line of borings represented in Fig. No. 5, almost at right angles to that in Fig. No. 4, we see a similarity in both, in the drop of the chalk under London; but, as in this line of borings all the sites south-east of London are on the chalk, and yet the base of the chalk is found only 182 feet below the foot of Shakespeare's Cliff, we see also evidence of the great amount of the higher chalk beds which are missing at Dover.

The thickening of the Jurassic, which with the Liassic rocks amounted to 613 feet, is not a little remarkable, although even this thickness is considerably less than at Netherfield, near Hastings, where, as will be remembered, Kimmeridgian had not been pierced at nearly 2,000 feet.

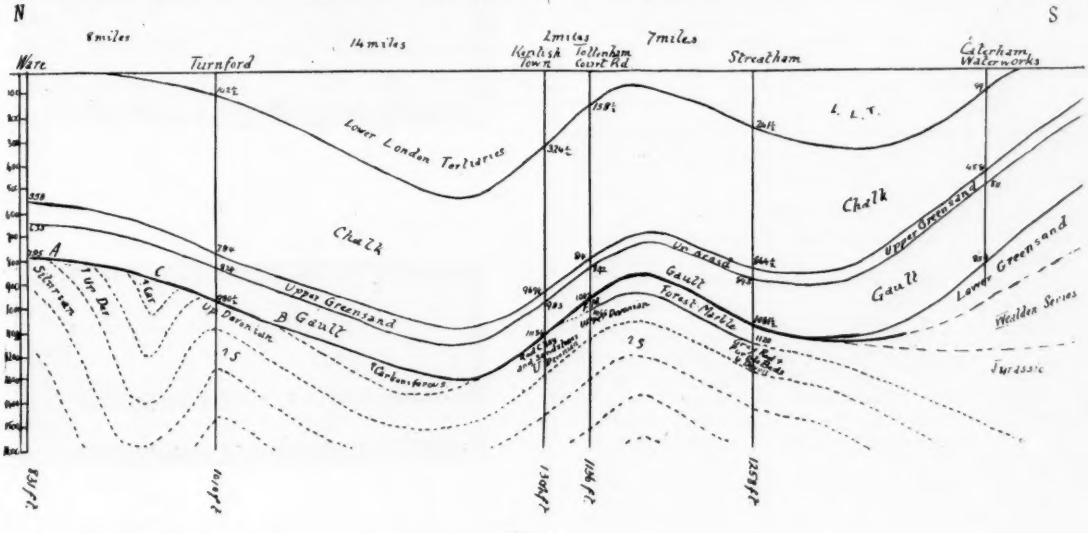


Fig. 4.

In the sections which illustrate this paper, it will no doubt have been noticed that the scale of the vertical depths is enormously greater than that of the horizontal distances. The latter is about one fifty-second of that of the former. This should be borne in mind in reading the diagrams.

The possibility of the opening up of Kent as a mining district is looked upon with considerable dis-

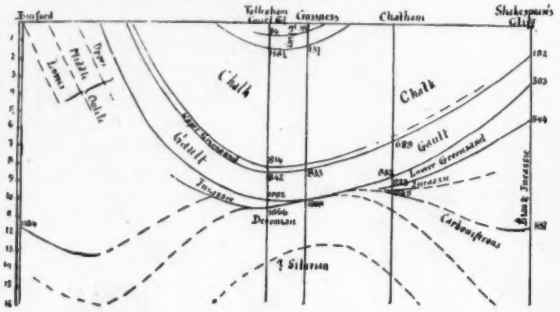


Fig. 5.

may by many persons. There is, I feel bound to think, but little possibility of danger to the general picturesqueness of the county. Whatever happens, mines would be few and far between. They would have to be worked at considerable depth as a rule, and the fact that sixteen years after the discovery of coal at Dover there has been so little result seems to show that there are many obstacles to the opening-up of the county as a mining district.

Denning's Periodical Comet (1894 I.)

DR. DAVID SMART has prepared a rough, sweeping ephemeris for this comet at its ensuing return. The perturbations have not been computed, but the positions given will serve as an approximate guide to those who may search for the comet. In October and November it will move through Gemini, Cancer, and Leo, and its distances from the earth will be about as under :—

Oct. 2, 119 millions of miles.
,, 30, 95 ,,
Nov. 27, 84 ,,
Dec. 17, 84 ,,

Its distance when discovered on March 26, 1894, was about 45 millions, and when last seen, on June 5, in the great refractor at Nice, 140 millions.

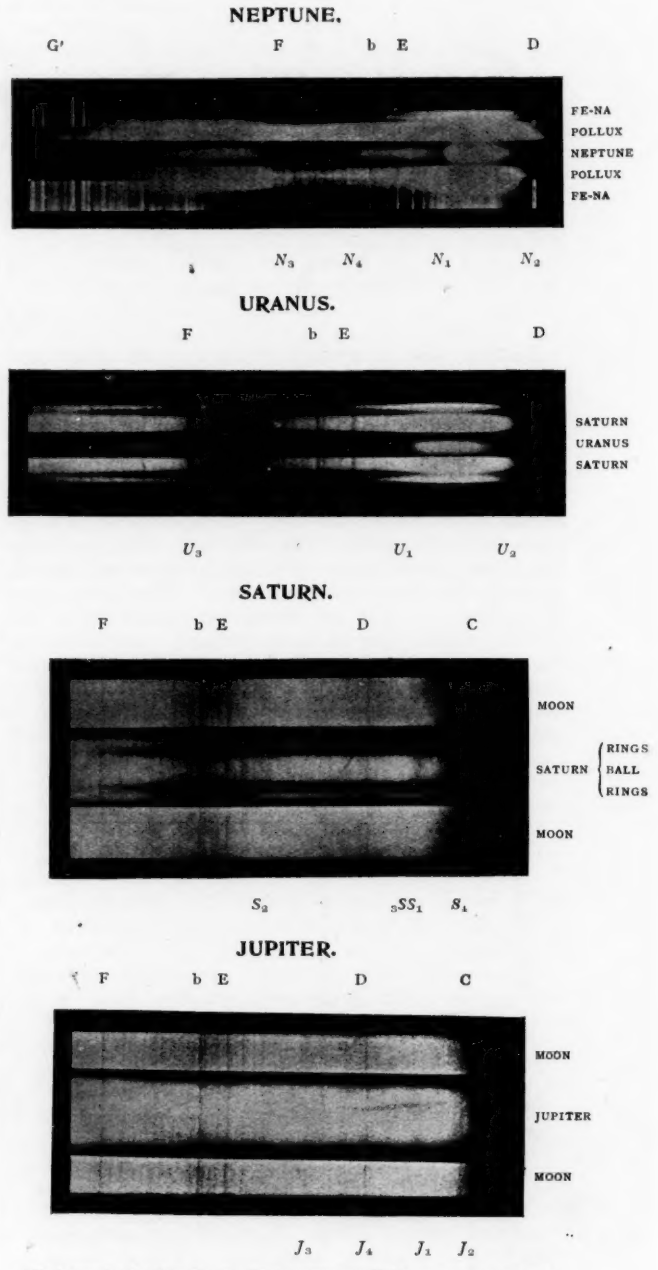
P.P. 1908. DECEMBER, 13.2.

			R A.	Dec.	Log. Δ	Brightness
Oct.	2	...	7 24 28	+ 20 13	0.1076	1.00
,,	6	...	7 39 52	+ 19 54	.0915	1.13
,,	10	...	7 55 52	+ 19 29	.0761	1.26
,,	14	...	8 12 16	+ 18 59	.0610	1.41
,,	18	...	8 29 0	+ 18 23	.0466	1.56
,,	22	...	8 46 8	+ 17 41	.0330	1.73
,,	26	...	9 3 44	+ 16 53	.0199	1.90
,,	30	...	9 21 32	+ 15 58	0.0083	2.09
Nov.	3	...	9 39 24	+ 14 59	9.9971	2.28
,,	7	...	9 57 20	+ 13 54	.9872	2.46
,,	11	...	10 15 20	+ 12 44	.9783	2.65
,,	15	...	10 33 24	+ 11 29	.9712	2.82
,,	19	...	10 51 24	+ 10 10	.9655	2.96
,,	23	...	11 9 16	+ 8 49	.9607	3.09
,,	27	...	11 26 52	+ 7 27	.9577	3.19

The Spectrum of Saturn.

By REV. J. T. W. CLARIDGE, M.A., F.R.A.S.

THE object of planetary spectroscopy is to ascertain the conditions and substances existing in the atmospheres of the planets. This problem is of a two-fold character. One part of it consists of the position and detection of absorption lines and bands, and the other the identification of the substances suggested by those lines and bands. The former has occupied the attention of many spectroscopists, with the result that a goodly number



Photographs by Mr. V. M. Slipher (Flagstaff Observatory, U.S.A.).
Reproduced by permission.

of absorption lines and bands have been discovered and their position determined. The latter, so far, has not yet been productive of any far-reaching results. Respecting the major planets, the only substance known with certainty to exist in their atmospheres is hydrogen in the envelopes of Uranus and Neptune. Thus, the study of the spectrum of each of the planets opens out a wide field of interesting investigation concerning the nature of the atmospheres of the group. It was in the autumn of 1905 that Mr. Slipher, astronomer of the Flagstaff Observatory (and to whose kindness and permission the writer is indebted for the accompanying plate and general notes), photographed the spectrum of Saturn for the purpose of making researches on the absorption of the planet's atmosphere. The plates used were especially sensitised to the orange-red, and the spectra obtained extend as far as the line C of Fraunhofer. The presence of faint bands, such as are found in the spectra of the planets, is shown more easily with low dispersion, and, consequently, the spectrograph employed contained only one prism. The slit of the apparatus was set upon the major axis of Saturn's system, and the ansæ of the rings are seen on the plates above and below the spectrum of the planet itself. The moon was photographed at about the same altitude, for the purpose of comparison, the two parts of which lie outside the spectra of the rings. Thus, these different spectra can be readily compared, and the detection of faint bands rendered easier. The similarity of altitude points out that the absorption due to the earth's atmosphere equally affected both spectra. The light reflected by the moon to the earth gives a spectrum like the spectra of direct solar light and the rays reflected by Saturn; consequently, if this last spectrum differ from that of the moon, these differences must be attributed to the effects produced by absorption and reflection in the atmosphere of the planet. In the study of Saturn's spectrum ten photographs were made, and a careful scrutiny revealed the fact that between the Fraunhofer lines of C and F several absorption bands were present. It is a somewhat remarkable fact that none of the bands observed in the spectrum of Saturn have been seen in the spectra of the rings. The reason, no doubt, is owing to the difficulty of observing any weak bands in such narrow spectra as those of the rings, but the presence of any strong band would be doubtless apparent. The absence of heavy bands from the rings demonstrates that if they possess any atmosphere at all it must be more rarefied than that surrounding the ball of the planet. This is corroborated by the visual observations of Keeler and the photographic by Hale and Ellerman. Moreover, it must be noticed that none of the absorption bands in Saturn's spectrum can be identified with those due to absorption in our terrestrial envelope. Mr. Slipher also remarks that he finds no trace of aqueous vapour absorption in Saturn.

The accompanying plate is a five-fold enlargement of one of the plates taken, and shows similar direct enlargements of those of Jupiter, Uranus, and Neptune. The following table shows at a glance the results of the study of the spectra of the four planets as arranged by Mr. Slipher :—

SATURN.		JUPITER.		URANUS.		NEPTUNE.	
λ	REMARKS.	λ	REMARKS.	λ	REMARKS.	λ	REMARKS.
						4861.	A narrow, strong band.
						5104.	Strong band.
						5225.	Broad and weak band.
		5406.	Blue component, largely solar.	4861.	F. stronger and broader than in Sun.	5396. 5408.	Faint local absorption, due probably to pair of solar lines.
		5427.	Yellow component, certainly Jovian.	5101.	Weak band.		
5430.	Fairly strong band.	5755.	Green component.	5404.	Increased absorption, strong solar lines in this region.	5425.	Secondary maximum in strongest band of the spectrum.
559.	Absorption in this region doubtful.	5769.	Centre of band.	5427.	Maximum of strongest absorption band in spectrum.	5432.	Point of maximum intensity of this band.
577.	Weak band seems to cover the region between solar lines 5759 and 5786.	5783.	Orange component.	5755.	A first maximum in second strongest band in spectrum.	5771.	Point of maximum intensity of violet (and stronger) component of band.
		6023.	Weak and doubtful.	5783.	A second maximum of intensity.	5780.	Maximum of red (and weaker) component.
6145.	Narrow band.	6192.	Strongest band in spectrum.		(Below D spectrum not photographed).		(Below D spectrum not photographed).
6193.	Strongest band in planet. It is not in the rings.	6437.	Orange edge of band.				
645.	Near the middle of a broad ill-defined band.	6465.	Centre of band.				
		6495.	Red edge of band.				

From the above table and the plates a close inspection will show that the planets which are telescopically similar possess also similar spectra. The spectra of Jupiter and Saturn present the same characteristics, while that of Uranus more resembles Neptune. The bands of λ 5430 and λ 6193 are stronger in Saturn than in Jupiter, whereas the band λ 646, which is strongly in evidence in the latter planet, is feeble in the former. These disagreements engender the supposition that the proportion of the gases which constitute the two atmospheres are not equal. The spectrum of Uranus differs from those of Jupiter and Saturn in that the bands at λ 543 and λ 577 are more accentuated. The line F of hydrogen is also more developed, and there are, besides, other faint bands not seen in Saturn and Jupiter.

The spectrum of Neptune shows that it contains a certain number of strong absorption bands. In the region comprised between the lines F and D, these bands are so evident that the character of the solar spectrum is unrecognisable. An Fe-Na spark and Pollux (Geminorum) of solar type were photographed

for comparison. The spectrum of the star is seen above and below that of the planet, and outside this double spectrum band appear the brilliant lines of Fe and Na. In a striking manner the spectrum of Neptune differs from that of Uranus; the bands in Neptune are all strengthened, and some lines are present which have not been observed in any other planet. The hydrogen line F is very dark. To sum up, it appears that free hydrogen is present in the atmospheres of both these planets. This fact, together with the presence of other dark bands, shows that the composition of the atmospheres of these celestial bodies is quite different from that of the gaseous envelope of the earth.

NOTE.—The numbers attached to the letters below each plate show the order of band intensity, N_1, U_1, S_1, J_1 being the strongest.

CORRESPONDENCE.

The Vegetable Caterpillar.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—In the February number of your magazine appears a short article, accompanied by an excellent photograph, by G. A. Laing, on the "Vegetable Caterpillar" of New Zealand. Vegetable caterpillars are *not* "hatched from the egg of a real butterfly," as suggested, but are the larval stage of certain night-flying moths. They do not drop "down to earth from the food plant chosen for them," because they are rhizophagans, and never leave their underground burrow. Neither do they "snatch one last feast of fungus spores." It is possible that the spores are occasionally taken in with the caterpillars' ordinary food, but it is much more probable that the caterpillar is attacked from without, the spores finding a lodgment in the folds of skin at the segmental divisions.

It is now generally recognised by New Zealand entomologists that the regular hosts of the sphœria fungus are the larger species of Porina, though occasionally other larvæ may be attacked. The latest published information on the matter is Mr. G. V. Hudson's paper, "Recent Observations Respecting the Origin of the Vegetable Caterpillar," Trans. N.Z. Institute, XXXIX., 195.

Yours, etc.,

A. PHILPOTT.

Invercargill, New Zealand.

[The vegetable caterpillars in the photograph came direct from New Zealand, and I gave the theory generally accepted there. As for "the spores finding lodgment in the folds of the skin" anyone who has handled these little wooden curios could tell you that is hardly likely. There is no trace of disease or disfigurement on them, and the fungus-shoots always grow from the head of the caterpillar. New Zealanders tell you these caterpillars are found on the "rota" tree, the *Metrosideros robusti* beneath which the *Claviceps* or *Sphæria robertsii* are found, and the natives dig up the fungus in search of these queer roots, which they love to eat.

G. A. LAING.]

Absorption Lines of Water Vapour.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—There is to-day a very fine development of the absorption lines, due to aqueous vapour, in the solar spectrum, in the positions given on page 292 of the December, 1905, issue of "KNOWLEDGE." If this wet weather continues they may be expected to last.

Yours, etc.,

T. H. B.

July 15, 1908.

The Changos.

A Chilian Reminiscence.

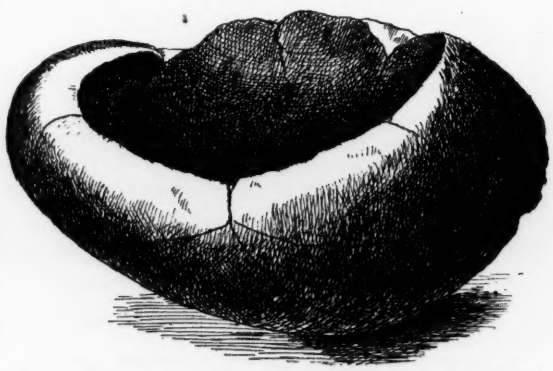
By OSWALD H. EVANS, F.G.S.

(*Continued from page* 160.)

LITTLE that has been said hitherto would lead the reader to consider the Changos to have attained to any higher stage of culture than the wandering savages of Tierra del Fuego. Allowing for the great difference in climate, the implements, food supply and general environment are almost identical. The people under consideration, however, possessed no mean skill in the manufacture and decoration of pottery.

In common use, they had a great variety of baked clay vessels, not only graceful in form, but painted, sometimes with conventional designs such as spirals, chequers, undulating lines and crescents, but not infrequently also with figures of men and animals, chiefly the guanaco.

The flat shallow pans are lavishly decorated inside



Food vessel of very crude manufacture found near the top of a grave-mound, in fragments, Playa Hueso, Taltal.

as well as outside. The pigments used were the mineral oxide of manganese, giving black; red oxide of iron; and white gypsum. The vessels were all made by hand without the use of the wheel, which, indeed, seems to have been unknown throughout South America, and never show incised or moulded ornament, in this respect differing in marked manner from the pottery in the making of which the civilised peoples of the North, the Chimus and Incas excelled.

From the discovery of a rude wooden paddle in a grave near Taltal, we learn that the Changos ventured upon the water. Under exceptional conditions favourable to the preservation of perishable materials, the remains of a feather head-dress were found near the same place. It is to be noted that Northern Chile is not so utterly rainless as the Peruvian coast, and consequently the grave relics are not, as a rule, in the remarkable state of preservation so delightful to the archæologist in that country. For this reason, it is difficult to obtain human remains in a fit state for scientific investigation, the sandy soil, impregnated with saline matter facilitating decomposition when moistened rather than acting as a preservative, as in Egypt and Peru. It may be remarked, however, that the human teeth are invariably large and sound, having perfectly flat crowns, a feature common to fish-eating

peoples, and due, as Mr. Hill Tout observes in his work on the Salish of British Columbia, to sand and grit masticated with the carelessly-prepared food.

Of their tribal organisation, religion, language and customs, history is silent. From marked contrasts observed in the contents of graves, the writer is persuaded that differences in rank and wealth obtained among this primitive fisher-folk. Some of the graves contain nothing more than one single battered arrow-head, whilst in other instances handsome weapons and elaborately-decorated pottery fragments mark the resting place of chief or medicine-man. In two cases the writer was so fortunate as to disinter the scattered beads of exceedingly long necklaces, composed of thousands of minute shell discs cut from the ubiquitous Concholepas, veritable "wampum-strings." To obtain these the whole contents of the graves were treated in a fine sieve, and the dust and heat of that operation, performed on an open plain, in the full glare of a Chilian sun, will never be forgotten. When strung on a thread, one of these necklaces was over six feet in length.

Traces of practices in all probability connected with religious beliefs may be deduced from the crudely-made earthenware bowls sometimes found near the summits of the low mounds covering the normal type of grave, and which originally held offerings of food for the departed spirit. Such a rite is a usual concomitant of the feeling which prompted the burial of weapons and ornaments. Hammer-stones, daubed over with red oxide of iron, were found in a cave shelter. A prominent spur of weathered volcanic rock, standing near high-tide mark, and remarkable from its odd resemblance to a gigantic human form, was found to have been painted with red oxide also, the pigment having been preserved from the weather by a thick coating of sea-bird guano. An enormous quantity of broken pottery was accumulated near its base. Rudely-painted figures of fish occur on prominent rocks in many places on the coast, leading one to suspect that the marine gods of the Chimu civilisation of the north were not without honour among a tribe depending almost for its very existence upon the produce of the sea.

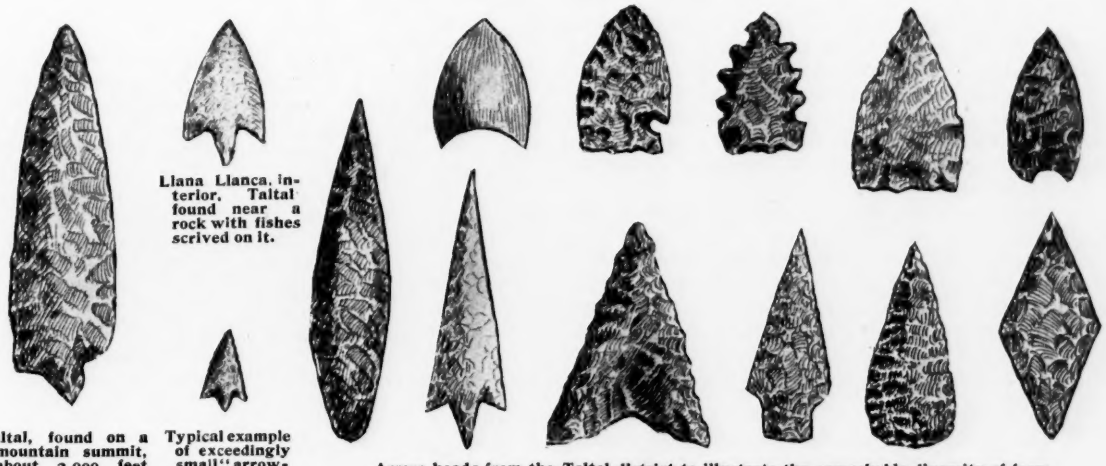
"Happy is the people that has no history." We search the pages of early writers almost in vain for any reference to the humble Changos. Miguel Balboa, in his "Miscellanea Austral," written about the year 1580, mentions them as being a people gentle and hospitable, of short stature, with flat noses.

Their very insignificance may have spared them the sorrows that fall upon more advanced peoples. The conquering armies of the haughty Inca swept past them along the inland road, subduing indeed, but leaving them in undisturbed possession of their desert domain. Almagro, returning in hot haste along the coast to Cuzco, from his ill-fated "conquest of Chile," must have seen and possibly contended with them. Later, the Spaniards subdued them, with all the races of the land save the valiant and ferocious Araucanians of the south. Early navigators shunned the inhospitable shore, wafted by the southerly breezes to the spoil of Peru and Mexico.

We obtain a very welcome glimpse of the Changos in the narrative of Cavendish's circumnavigation, performed about the year 1587, as printed in Hakluyt. Here is the passage in full:—

"The fifteenth wee came thwart of a place which is call'd Morro Moreno," near the present Antofagasta, "which standeth in 23 degrees ½, and is an excellent good harborough; and there is an Iland that maketh it an harborough; and a ship may go in at either end of the Iland; here wee went with our Generall on shore to the number of 30 men; and at our landing the Indians of the place came down from the rocks to meete with us with fresh water and wood on their backs. They are in marvellous awe of the Spaniards, and very simple people, and live marvellous savagely. For they brought us to their bidings about two miles from the harborough, where wee saw their women and lodging, which is nothing but the skin of some beast layed upon the ground, and over them, instead of houses, is nothing but five or six sticks layd across, which stand upon two forkes with stickes upon the ground and a

ARROW AND LANCE HEADS.



Taltal, found on a mountain summit, about 2,000 feet above the sea.

Llana Llanca, interior. Taltal found near a rock with fishes scrived on it.

Typical example of exceedingly small "arrow-head," Taltal.

Arrow-heads from the Taltal district to illustrate the remarkable diversity of form. The figures are natural size.

few boughes layd on it. Their diet is raw fish, which stinketh most vilely. And when any of them die, they burie their bowes and arrowes with them, with their Canoa and all that they have; for wee opened one of their graves and saw the order of them. Their Canoas or boates are marvellous artificially made of two skinnes like unto bladders, and are blowen full at one ende with quilles; they have two of these bladders blowen full, which are sewen together and made faste with a sinew of some wild beaste; which, when they are in the water swell, so that they are as tight as may bee. They goe to sea in these boats, and catch very much fish with them, and pay much of it for tribute unto the Spaniards; but they use it marvellous beastly."

In the above paragraph we catch sight for a moment of the Changos as they were a century of two before their final extermination or absorption into the dominant race. There is no reason to suppose that the somewhat unfavourable picture drawn in the quaint style of the Elizabethan seaman is other than veracious. "A very ancient and fish-like smell" hangs round the dwelling of the Chilian fisherman to this day, nor is his treatment of his catch greatly to be commended from the point of view of cleanliness.

The extinction of the Changos must have been a very gradual process, due in great measure to forced labour in the mines and the oppression of the Spaniards. A few isolated families of mixed blood seem to have survived to within the memories of men now living, but the great commercial activities that during the latter half of the last century occasioned so great a demand for labour throughout the north of Chile effectually completed the absorption of the Changos into the mass of the population. The race may perhaps be detected in members of the dark-skinned, short and thick-set "rotos" with almost Mongoloid features, who make up a considerable proportion of the labourers on the nitrate fields of Atacama.

Answers to Correspondents.

W. F. Badgley (Devizes).—There is no experiment which decides crucially between the one and the two fluid theory. Although *something* travels outwards from both poles during an electric discharge, that "something" is not electricity, but particles of metal, etc., torn off the electrodes.

I take it that your query refers to the negative stream in a vacuum-tube; for the *brush* at ordinary pressures occurs at the positive terminal. It is quite certain that this stream travels *from* the pole, and that it therefore consists of *negative* electricity. If there is only one kind, we feel certain that it must be negative. But there are some recent experiments of Jean Becquerel indicating the existence of positive as well. If these are confirmed, the one-fluid theory must go.

G. S. (Smyrna).—The best reagent for reducing the colour of dyestuffs is a solution of titanous chloride, now obtainable as a commercial product under the name of "stripping salts." Preliminary experiments will be necessary to determine the right strength to use in a particular case. If this does not answer a solution of stannous chloride might be tried. Chloride of lime has a very injurious action upon wool, causing it to shrink and become tender.

Margate Reader.—Re Halley's Comet.—We are not aware of any reward being offered, but several experts are at work on the computation of ephemerides. For other information see "KNOWLEDGE," May, 1908, and March, 1907.

The Use of Animals in Experiment.*

By PROFESSOR E. H. STARLING, F.R.S.

IT is hardly possible to discuss the subject without some common understanding on the point of view from which we are to consider the rights of animals and the rights of man over animals. I shall not occupy your time by dealing with the views of those people who consider it unlawful to take the life of animals under any pretext. For the vast majority of civilised mankind, including the inhabitants of these islands, the rights of animals only exist in relation to the necessities of man. Those animals which are harmful to man directly or indirectly are destroyed without compunction. Those animals which are useful to man either as food or as muscular machines, are bred under such conditions as will bring out to the utmost their usefulness to man. The horse it taught to obey the rein and the whip. The first lesson he has to learn is that it is pleasanter for him to do as he is directed than to follow his own instincts. In the training of children, as in the training of animals, we employ the methods of reward and punishment. In the case of the child, it is in order that he shall live as an orderly member of the community with as much pleasure and profit to himself as possible. In the case of the animal the reward is administered and pain inflicted in order that the animal may learn that his easiest way of life is in the service of his master—man.

To the lives of animals no importance is attached. We consider it better to destroy an animal than to permit it to exist under conditions which may be either painful to itself or dangerous for the community. In the Dogs' Home, supported at the expense of the charitable, over 20,000 dogs are destroyed annually. It is considered merciful to shoot an old and worn-out horse or one which has undergone such an injury as to unfit it for further service. Millions of animals are slaughtered annually for food and for furnishing articles of clothing.

Man's attitude to animals consists, therefore, in allowing them to exist or encouraging their existence in direct proportion, as they, by their activity or by their bodies, add to man's powers of existence, and aid him in the struggle for life. It is difficult, therefore, to see how it is possible to object to the use of animals for the purpose of acquiring knowledge, especially when this knowledge is directly related to the preservation of mankind against disease and death. Man's advantage over animals lies largely in the fact that by the acquisition of the power of speech it has become possible for each individual to enjoy and utilise the whole past experiences of the race. The advantage of civilised man over the savage lies in his control through science of the forces of Nature; in the fact, that by utilising these forces he can multiply his own power ten or a hundred-fold, and by his knowledge of Nature's laws is able to predict the consequence of any given course of action. The enormous gains of civilisation during the last century have been all determined by advances in pure knowledge. The electric telegraph, the dynamo machine, each owe their origin to the purely scientific, and as it seemed then, uninteresting researches of Ampère and Oersted on the effect produced by leading a galvanic current through a wire round a magnetic needle. Wireless telegraphy is due

* An address delivered at the rooms of the Royal Society of Medicine, June 26, 1908.

to the highly abstruse speculations and experiments of Faraday, Maxwell, and Hertz, in the region of pure physics. Is there any reason to believe that the experimental method which has proved so fruitful to the world of man in the physical sciences in improving his material condition should be inapplicable when we come to deal with the effects of his environment on man himself?

This subject forms the whole basis of medicine. Man is liable to disease due to hereditary causes, to injuries by external conditions, to invasion by foreign organisms. By these diseases he is subjected to pain, physical and mental, which impels him to find, if possible, some way of escape from the disorder, and the office of the medical man is so far as possible to direct, by treatment or otherwise, the processes occurring in the diseased body towards the healthy condition. The aim of medicine is restoration to health, the prevention of disease. Let us take the first of these—restoration to health. How can this be effected without knowledge? We should not expect the clock-maker to be able to mend a clock unless he was acquainted with the way in which the clock worked when it was in a sound condition. In the same way we expect our medical men to know what is the working of the body in health, what is the matter with this working when the body is diseased, and what it is necessary to do in order that the body may be made healthy again. Is there any way by which a medical man can acquire this knowledge except by experiment? If we make the term "experiment" as inclusive as its French equivalent, "experience," we might say there is no other way of acquiring knowledge than by experiment or experience. And this experiment must be on an organism of like structure to man. Previous to the present century, a certain amount of medical knowledge had been obtained by what is called clinical experience, and this method of acquiring knowledge is still actively pursued and forms an essential part of our means of acquiring the requisite knowledge. But what does clinical experience mean? It means that we fold our hands while Nature afflicts men's bodies with all the divers diseases to which creation is susceptible. Here experiments are performed, but they are performed blindly by Nature and we interpret them as best we may, without power of determining the conditions, and therefore of dissociating one process from another in the complex which makes up the disease. The result is, that by this method alone, the method of observation as it is called, the progress of knowledge is slow and its steps halting. Take, for instance, a case of heart disease. What idea can we form of the nature of this disease without knowing that the blood circulates, without knowing the part played by the heart in this circulation, without knowing the office of the vessels in the determination of the blood pressure, in the formation of dropsical fluid, and so on, all facts which are hidden from us even in the disease itself, and can only be studied and analysed by experiment on a living animal, constructed so far as concerns its circulatory mechanism on the same lines as man himself? In consequence of the experience of countless ages, we may arrive at the idea that digitalis is useful in heart disease, but what has this experience meant? It carries with it the memory of countless cases in which all sorts of nauseous drugs have been given without rhyme or reason, and of numberless cases of disease in which all treatment was unsuccessful. Not only does such clinical experience involve countless misery to generations of mankind, but the knowledge gained in this way is apt to be inaccurate, and therefore harmful to man. It is only within the last 30 years that the real action of digitalis and indications as to what cases of heart disease it should be used for, have been brought to light by experiment. By using animals in an experiment, we can analyse one function of the body after another, and arrive at some idea as to how they work together to produce the healthy organism. Without this knowledge all medicine must be quackery, and further, control of disease is impossible.

The waste by this method of clinical observation by itself in human life and suffering may be illustrated by one more example taken from surgery. Some 30 years ago, Czerny had under his care a woman with serious disease of one kidney. At that time surgeons were unaware how far this organ would permit of operative interference, and especially whether, if one kidney were removed health could be maintained by means of the other kidney doing the work of both. One of three courses were open to the surgeon. He might cut out the diseased kidney, trusting to the chance that the result might be successful. He might shrink altogether from interference, allowing the patient to die of her disease. On the other hand, it was open to him as a man of science, to supply himself with the knowledge that he lacked, and in the light of this knowledge to conduct his treatment of the patient. He preferred the last alternative. In a small number of dogs he cut out one kidney and found that the animals remained in excellent health. Emboldened by these results, he argued that if one kidney were sufficient for the needs of an animal, it could also rise to the occasion in the case of man. He excised the diseased kidney, restored his patient to health, and introduced into surgery the operative procedure which has been ever since of inestimable benefit to man.

The cost of uncontrolled experience, *i.e.*, of simple observation without experiment, in human life is still more markedly shown when we come to deal with the infectious diseases. What is our sanitary advance which has been so fruitful in the saving of lives due to? It is due to a deduction from the experience of many centuries and many epidemics that dirt and disease are in some way connected, and that water may in many cases serve as a medium for the spread of epidemic disease. But at what cost? Time after time the communities of the world have been ravaged by disease, and the deductions which we have, which seem in themselves fairly simple, have only been obtained as the result of the sacrifice of millions of human lives. The European's experience of plague taught the nations nothing except to flee from the pest. Up to within a few years ago nothing was known as to the cause of the plague, as to the reason for its prevalence in certain parts, or as to the reason why, after a period of subsidence, it would break out again in all its former vigour. During the last few years millions of lives have been lost in our great dependency from this disease alone. With all our sanitary tenets derived from the European experience of the last 50 years to guide us, our medical officers and administrators in India were powerless to prevent the recurrent outbreaks of the disorder, and why? Because of lack of knowledge. Only within the last few years, as the result of the direction of the attention of scientific men to this disorder, has the cause of plague been found. Having found the cause it was then necessary to determine the method in which the bacillus, which was responsible for the disease, was transmitted from one patient to another. Until this was found all means of preventing

the spread of the disorder were so many shots in the dark. They were, in fact, experiments on man on a large scale, every unsuccessful shot involving the sacrifice of thousands of lives. At the present time, thanks to the devoted labours of a small band of workers in the Indian Medical Service and at the Lister Institute, we know that the disease of plague is spread by rats, and transmitted from these animals to man by fleas. It is now possible to concentrate the efforts of our administrative officers on these facts alone, and for the first time it is possible to undertake the campaign against the disorder, guided not by theories or guesses, but by facts. Extirpate the rat or prevent the access of the fleas from the dying rat to the human subject and the spread of plague is stopped.

In the case of many of the infective disorders, the method of observation, *i.e.*, by Nature's ruthless experiments on man, have proved of little avail. Bitter experience taught man that malaria is to be found chiefly in marshy places, and might be avoided by regarding these spots as uninhabitable by the white man. Whole areas of the earth's surface, as the result of this experience, were to be cut off from civilisation or from ministering to the needs of civilised man. Observation of these victims of Nature's experiments by men trained in the experimental methods of the laboratory showed a constant association of a micro-organism with this disorder. Experiments on birds and on mosquitos showed that similar disorders could be carried by these insects from animal to animal. The final experiment had to be performed on man, and was carried out on volunteers, who willingly undertook the risk of life-long infection for the sake of adding to knowledge and our control of one of the great plagues of mankind. A few experiments sufficed to blow away all the clouds of theory, malarial effluvia and so on, which had cumbered medicine from the Middle Ages. Malaria was found to be a human disease carried from man to man by the mosquito. Prevent the propagation of the mosquito or prevent the transmission from the diseased to the healthy man, and malaria is stamped out. The cause of yellow fever is perhaps still more remarkable. Here we conclude by circumstantial evidence and by analogy, that an organism is present, although the organism has never yet been seen, possibly because it is too small even for the highest powers of the microscope. Conclusive experiments as to its propagation were made like those of malaria, on medical men who volunteered themselves for the purpose. It was shown that here, too, the transmission of yellow fever is from man to man by means of certain species of mosquito. The transmission, however, was only effective at certain stages of the disease, and the mosquitos only became effective after a certain lapse of time after they had sucked blood from the patient. But what is the result of these few experiments? We can now say that the tropics have become, or will become, habitable by the European. The great scheme of building a canal through the Panama Isthmus, imagined by De Lesseps, had to be abandoned only a few years ago owing to the fact that labourers of any nationality introduced into the Isthmus died off like flies. The forces of disease proved themselves for a time greater than the intellect and the energy of man. But only for a time. By the experimental method we have found how to combat these diseases, and now under the masterly generalship of the United States officers, the building of the canal is proceeding, and the health of the labourers is not inferior to that in any other part of the States. Yellow fever and malaria have been stamped out. As a result of this knowledge the pest-ridden Campania is once more coming under cultivation; Ismailia has been freed from malaria, and from all parts of the world we hear of greater or less success, according as the measures indicated by science are applied with more or less vigour.

Five years ago, Malta fever was responsible for 75,000 days of sickness among our soldiers and sailors every year. By the experimental method the disease has been practically abolished. The masterly investigations of Bruce first resulted in the discovery of the cause of disease, and then in the simple fact that practically the sole mode of its transmission on the island of Malta was by means of goat's milk. For the lack of this simple piece of knowledge we have had for all these years these thousands of days of sickness, deaths, and spoilt lives among the servants of the State, though the observational method was being applied so far as lay within the power of the intelligent men in control of the troops.

Twenty years ago, when we had to deal with a case of diphtheria, the only means at our disposal was the maintenance of the strength of the patient by feeding, the performance of tracheotomy when his air passages became obstructed, and various topical remedies of very doubtful benefit. Von Behring showed by experiment that after injecting the poison of diphtheria in repeated small doses into an animal, the serum of this animal had the power of neutralising the poison. If it were injected into another animal at the same time as the poison, no ill results followed. He showed then, that if larger doses were injected, even after the injection of the poison, a cure might be effected, provided the injection of the anti-toxin serum was not made too late. As the result of these experiments on animals, diphtheria anti-toxin was introduced into general practice, and is used universally by medical men throughout the world. The value of anti-toxin was established by experiments on animals. It would be only necessary to take two hospitals or one hospital with two wards, and admitting patients alternately into either ward to treat one lot with anti-toxin and leave the other untreated. That would be the method of clinical observation advocated by so many of the opponents of vivisection; it would be an experiment on man, but it would not be considered justifiable in the present state of our knowledge. We have, however, distinct and irrefutable evidence of the value of diphtheria anti-toxin in the effect observed by administering this drug at different stages of the disease. As we should expect from our experiments on animals, we find that administered on the first day, its result is always successful, and we obtain 100 per cent. of cures. On the second day we get a small percentage of deaths, and these increase with the number of days that have elapsed since the outbreak of the disorder and the injection of the anti-toxin. If the anti-toxin were without effect, the day on which it was administered would not affect in any way the death rate. It is impossible, however, within the limits of time at my disposal, to bring before you the whole of the great mass of evidence which has accumulated during the last thirty years in proof of the enormous advantage that the experimental method has been to man. But our opponents have one last refuge. They say, even admitting these benefits, they are not worth the cost of the experiments in animal lives and animal suffering. They call attention to the 40,000 mice which have been inoculated with cancer in the so far unsuccessful attempt to discover the exciting cause, and the remedy

for this dreadful disease. But are you aware that every year 31,000 patients in England and Wales die of cancer? Are you aware, that, assuming there are 160 women in this room and the average age is 30, that 20 of them will die of cancer? Is there one person in this room who has not lost some friend or relation by this disease? The knowledge of Malta fever was obtained as the result of experiments on a few hundred animals. Can you compare the amount of pain inflicted in such experiments with the 75,000 days of sickness which were saved every year as the result of the knowledge gained thereby?

And what is the amount of pain? In the case of inoculation the result, if the inoculation is effective, may be a state of disease which brings about the animal's death a few months or years earlier than it would have occurred in the natural course of events, if the animal had not been previously destroyed by violent means. Only in one disorder, so far as I am aware, can one speak of physical pain resulting from the disease, and that is in the case of tetanus, but the vast majority of the 60,000 or 70,000 inoculations which are carried out in the year have reference to other infective conditions in which the result of the injection is a malaise, a state of sickness, but not one of physical pain. Many of you have been the recipients of tracts giving gruesome descriptions of experiments carried out in physiological laboratories, in which implication is made that these experiments are painful, that they are carried out without anæsthetics, or that the anæsthetics when they are employed are a sham. These statements are untrue. Only once, so far as I know, has such a statement been made directly implicating by name the experimenter. In this case, as you all know, the facts were submitted at the earliest opportunity to the Law Courts, where it was established that the anæsthesia was as perfect as it could be. Are you aware that of all the disturbing elements in an experiment, the presence of acute pain would in 999 cases out of 1,000 be the most important, and therefore, apart from any humanitarian motives, it must be the design of the experimenter to abolish any possibility of pain so far as lies in his power. I have already stated on several occasions that in the whole of my experience in physiological laboratories, I have never seen pain inflicted on an animal. Such terms as the torture-chamber of the physiologist are ridiculous perversions of the facts. My laboratories have always been open to the hundreds of medical and scientific students who have passed through my courses, and they would bear me out in my statement that pain does not exist in the physiological laboratories of this country, and that the cases in which a certain amount of malaise and discomfort are produced by experimental means only form an insignificant minority of the total number of experiments carried out in these laboratories. Anti-vivisectionists are fighting a figment of their own brains. They say their aim is to prevent cruelty. Let them go out into the slums and alleys of London and help the children and the women who are slaving themselves to death in pain and sickness to keep body and soul together. Let them approach their noble vice-presidents and take means to prevent the sufferings inflicted on animals in the pursuit of pleasure or the satisfaction of the lust of slaughter, but if they love their own kind let them desist from further slanderous campaign against men who are giving up their lives to the search for knowledge in the sure faith that by knowledge alone will come the conquest of disease and the victory over pain.

The Eighth Satellite of Jupiter.

A Suggestion of the Probable Origin of the Jovian Satellitoids.

By PROF. TARRIDA DEL MARMOL, B.Sc., C.E.

MR. GEORGE FORBES, in a letter published by *Nature* about the discovery at Greenwich of the eighth satellite of Jupiter, conjectures that the object may be the long-lost Lexelles comet of 1770. The reasons he gives to support his assumption prove that such an hypothesis is perfectly reasonable.

Notwithstanding, I feel rather inclined to believe that the eighth satellite of Jupiter, as well as the sixth, the seventh, and several others which may some day be discovered by the photographic process, are not lost comets at all, but former asteroids which have been, or will be, captured by the giant planet.

The successive discoveries of Achilles, Patrocles, Hector, and C. S., whose distances from the sun are approximately the same (a little greater for two of them, and a little smaller for the other two) as the distance of Jupiter from our central body, compel us to believe that there are, or have been, many asteroids in the neighbourhood of the Jovian path.

Generally, those which occupy the position of inferior planets relatively to Jupiter will have a shorter period than the giant planet, and those which occupy the position of superior ones ought to have a longer period.

It is easy to show that in both cases the asteroids are free from being captured by Jupiter. But in the very particular cases when the asteroids are practically at the same distance from the sun as Jupiter, and are nevertheless inferior planets relatively to it, the capture appears unavoidable.

In the first case, the asteroid, being an inferior planet and its period shorter than that of Jupiter, when it approaches it its velocity increases, then its distance from the sun decreases, and consequently it goes farther away from Jupiter, to a sufficient distance to avoid its being captured. After it has overhauled the giant planet, the attraction of this will tend to decrease its velocity, then to increase its distance from the sun and consequently to oblige it to resume its former path, until, after many revolutions round the sun, it approaches Jupiter again and performs the same process which we have just been describing.

In the second case, the asteroid being a superior planet with a longer period than Jupiter, when this last approaches such asteroid, the velocity of the latter diminishes, then its distance from the sun, and also from Jupiter, increases, according to the law of areas, until Jupiter has overhauled the small planet, when the velocity of the latter will again increase compelling it to resume its original path.

In fine, the same cause, that is, the attraction of Jupiter, which threatens the asteroid, is also the very cause which saves it from being captured, thanks to the permanent working of the law of areas.

But what will happen when, the asteroid and Jupiter having practically the same distance from the sun, the small planet will be the inferior one?

Such may be the case in several instances, because

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the mass m' of the asteroid being practically *nil* comparatively to the mass M of the sun, its distance d to the centre of gravitation is really equal to its distance to the centre of the sun, while the centre of gravitation of the system sun-Jupiter is somewhat distant from such centre, since the mass m of Jupiter is only about one thousandth of the mass of the sun. In this particular case, it may be shown that the asteroid will have, though being the inferior planet of the two, a period t' longer than the period t of Jupiter, and will be consequently captured some time by the latter, except, of course, in the very special circumstance, when the sun, the planet, and the asteroid will always gravitate at the vertices of a triangle constantly equilateral, according to the celebrated theorem of Lagrange.

Using the above data, and d being the same for both planets, we may write:

$$\frac{d^3 : t^2}{M+m} = \frac{d^3 : t'^2}{M+m'}$$

or

$$\frac{M+m'}{M+m} = \frac{t^2}{t'^2}$$

and as

$$M+m > M+m',$$

we have

$$t'^2 > t^2$$

and again,

$$t' > t. \qquad q.e.d.$$

Thus, the asteroid having a longer period, and being at the same time an inferior planet relatively to Jupiter, it will find, when approached by the latter, that its velocity decreases; then its distance from the sun increases, and, consequently, its distance from Jupiter diminishes. In other words, while Jupiter is approaching it, and until it is overhauled by the giant planet, the asteroid, instead of getting safely away from it, as such was the case in the former instances, will get closer and closer to it, running the risk to reach a point where the Jovian action will have overcome the Solar one. This, of course, may be avoided many and many times, according to the respective inclinations of both orbits. But when the positions of the planets will be such that their distances are small enough, the capture will be inevitable.

That may justify the assumption that the asteroids, which were in this particular case just after the heavenly catastrophe which led to their formation, whatever this catastrophe may have been, either have been already, or will be some day, captured by the giant planet.

According to the respective positions of Jupiter and the captured asteroid in the critical moment of the capture, the movement of the new Jovian satellitoid will be either direct like the VI. and the VII., or retrograde, like the VIII.

I do not think it impossible, although this is a bold statement, for the boldness of which I beg to apologise to the readers of "KNOWLEDGE," that the direct satellitoids (Hyperion and Themis) of Saturn and the retrograde one (Phœbe) have the same origin.

It would be enough, for this, to assume that the world of the asteroids, which has only recently been found to extend beyond the orbit of Jupiter, is really extending far enough to encroach upon the regions of the ringed planet itself.

Photography: Pure and Applied.

By CHAPMAN JONES, F.I.C., F.C.S., &c.

The Theory of Light Action.

Mr. Wilder D. Bancroft, writing in the American *Journal of Physical Chemistry*, has recently advocated the adoption of the conception set forth by Grotthuss in the year 1818, that the action of a ray of light is analogous to that of a voltaic cell. He shows that in a great many cases—indeed, he claims *all* cases, so far as they are known—the changes produced by light are similar to those that result from electrolytic action, and he argues that sensitisers of every kind are depolarizers, that is, agents that prevent the accumulation of the immediate products of the electrolysis, which otherwise would retard or altogether inhibit the change. Dyes, to be effective as colour sensitisers, must be decomposed by light and must either be reducing agents, or be converted into reducing agents by the action of light. But it does not follow that the sensitiveness of the dye to light will be proportional to its sensitising power, because this latter "depends on the potential, while the rate of decomposition depends also on the unknown 'chemical resistance.'" On the other hand, a general agreement between light-sensitiveness and sensitising power is to be expected, and, as a matter of fact, is found to exist. A dye may stain silver bromide, but if it is not a depolarizer, directly or indirectly, it will not act as a sensitiser. Mr. Bancroft maintains that the spectrum maximum of sensitising action of any given dye agrees with the maximum spectrum absorption of the silver bromide stained with it, as originally found by Eder, and he ascribes the divergence that Acworth found when he measured the absorption and sensitiveness of the same emulsion in every case, to the absorption of the stained film adding itself to that of the stained silver salt. Grotthuss, ninety years ago, formulated the law that is usually ascribed to Draper, namely, that only those rays of light that are absorbed can produce chemical action. Mr. Bancroft considers that all sensitisers are similar in their action whether they belong to the class called "chemical" or the class called "optical" sensitisers, and that it would be more rational, instead of using these words, to distinguish them as depolarizers with marked absorption bands and depolarizers without marked absorption bands.

What some, perhaps, will regard as a flaw or omission in the general argument is that no distinction is made between those cases in which considerable and easily recognisable decomposition is caused by light, and those cases in which a chemical change has not yet been proved, namely, the change of the silver salt from the undevelopable to the developable condition. In common photographic language, the same theory is applied without discrimination to printing-out and to development processes. It must be allowed that there are difficulties in the way of accepting the idea that these two classes of changes are exactly the same in kind, and differ only in extent.

Reduction Reactions.

Dr. W. Scheffer (*Brit. Jnl. Phot.*, p. 472) has obtained further interesting results in comparing the action of ammonium persulphate with other reducers. He finds that Farmer's reducer, whether made alkaline or not, ammonium persulphate with ammonium thiocyanate, and the permanganate reducer, have a solvent action that is rapid in proportion to their diffusibility and produce "harsh" results, that is, they

remove the image as they penetrate the film, so that a transverse section of the film shows clearly to what depth the reducer has removed the image. A very important observation is that if a part of a dense image is dissolved off from a plate and put upon a new plate in a thin layer, and if now the original and the thinned out part are placed in ammonium persulphate solution, the original dense deposit is considerably reduced before there is any apparent change in the thinner layer. This indicates that the greater amount or proportion of action of the persulphate on the denser parts of an image is not due to a difference in the material that constitutes the silver image in the thin and the dense parts respectively, as has been supposed, but rather to the difference in disposition of material that may be identical in character. Ammonium persulphate, as is well known, when it reduces an image appears to do so by rendering the particles more transparent, or by exchanging the black particles of the original image for some other substance that is not so black. Dr. Scheffer has found that the same thing occurs with Farmer's solution, for after such strong reduction by it that the film appeared to the naked eye like clear glass, he found by careful examination that the delicate remains of the granules showed distinctly the same configuration as was evident before reduction. Thus ammonium persulphate is not quite so exceptional in its behaviour as at first it appeared to be, but, it may be added, the reason for its peculiar action still remains to be discovered.

The Donisthorpe Process.

I referred to this process two months ago, and since then I have had, by the courtesy of the proprietors, an opportunity of working it myself. The hardening solution, with which the negative is treated before dyeing it, is a vandium-iron intensifier, and its effect is not only to harden the film, but to change the grey image to a bright green colour. The image of one negative that I experimented with was changed to a bluish green, but this would not give a successful print. I failed to discover any reason for the exceptional behaviour of this plate. The negative should not be over dense, and the patentee is specially emphatic on this point, but it may easily be too thin and so yield prints with too little contrast. A clean negative with a tendency towards under-exposure, but of sufficient density to yield a good print by the ordinary methods, is the kind of plate that I find to give the best results. After the negative has been soaked in the strong solution of the dye, it is washed for a minute or so and the surface well cleaned by rubbing it with the soft part of the hand or a pad of cotton wool, and a piece of the gelatine coated paper squeegeed to it. As the dye solution diffuses into the gelatine film there is a slight loss of sharpness, but this is hardly perceptible under ordinary conditions, though by prolonging the contact it can easily be made very considerable. It requires some little practice to work the process successfully, and it must be remembered that the prints will not stand water; by washing one for a quarter of an hour hardly a trace of the image remained.

The Oil-pigment Process.

The editor of the *Amateur Photographer and Photographic News* has arranged a small exhibition of oil-pigment prints, which includes seventy-two examples by British and foreign workers, at his office, 52, Long Acre. Admission is free, and although the pictures cannot claim to be called photographs, as they are produced by hand-work, on a photographic basis, they will interest those who desire to combine the freedom of the brush with the facility of photography.

The Brilliant Midnight Heavens, July 1 and 2.

By FRANK C. DENNETT.

CERTAINLY it is seldom that such a sight has been witnessed in England as that which was seen this year on the nights of June 30-July 1, and July 1-2. The light gave some the impression of a fire northwards, and they sought higher ground to see better, others took it to be auroral. It was mostly white, though close down to the horizon it was decidedly reddish, and there was an occasional pinkish strip higher in the heavens. Compared with the aurora it was, however, essentially different. The aurora proper radiates round the magnetic pole, and so in England the radiation is from a point some 16° west of north. The aurora, again, usually presents a dark base, having a circular upper outline, above which the brightness forms an arch, this brightness being frequently radial, the radiations often having a motion like the hands of a clock. There are coloured evanescent clouds also often seen of a reddish or greenish colour. Examined with the spectroscope, the light gives certain distinctive bright lines, especially one in the green. Aurora usually occurs simultaneously with the passage of an active area within a few solar degrees of the centre of the sun's disc, and is generally accompanied by a marked disturbance of the magnets. The spectroscope this time showed no bright lines, however.

The present display differed essentially from these general features, for the centre of brightness followed the sun, being west of the north point before midnight, and east after. The brightness, too, went right down to the northern horizon, whilst there seemed a complete absence of radiation. Some long pinkish streamers were certainly not radial. The sun has shown no phenomena in any position at all likely to have raised such a disturbance. The observers at Stonyhurst College describe it as being at 11 p.m., "the reverse of an aurora, a bright arch and a dark exterior. Arch sharply cut on the convex. Dark exterior looked like a high fog, but the stars showed it to be clear sky. Midnight: Dark exterior, giving way to a twilight sky. Sunset colours: Especially red cirrus; no flickering. July 1, much the same. Magnets quite quiet."

The Rev. W. Sidgreaves, Director of Stonyhurst College Observatory, in kindly sending the above details mentions that he has never seen anything like these midsummer skies. What are they? How are they brought about? The probable answer seems to be that our atmosphere was in a highly refractive state, which so bent the sun's rays to an abnormal extent. This effect was increased by the presence of a great amount of ice-crystal in the upper regions of the atmosphere. To write thus may seem unwarrantable to the casual reader, and yet it is an undoubted fact. Solar halos were observed by the writer June 1, 3, 8, 13, 16, 22, 30, July 3 and 4, lunar halos, June 8, 11, and 12, whilst Col. E. E. Markwick saw the usual solar halo, and part of the larger (47°) halo on June 12. My own observation on June 8 showed not only the complete halo at 22°, but mock suns both east and west, and a portion of an arc, like tangential wings on the top point of the halo. All these phenomena point clearly and distinctly to this one fact, ice-crystals in the upper air. The effect of these would be to intensify the results brought about by the atmospheric refrac-

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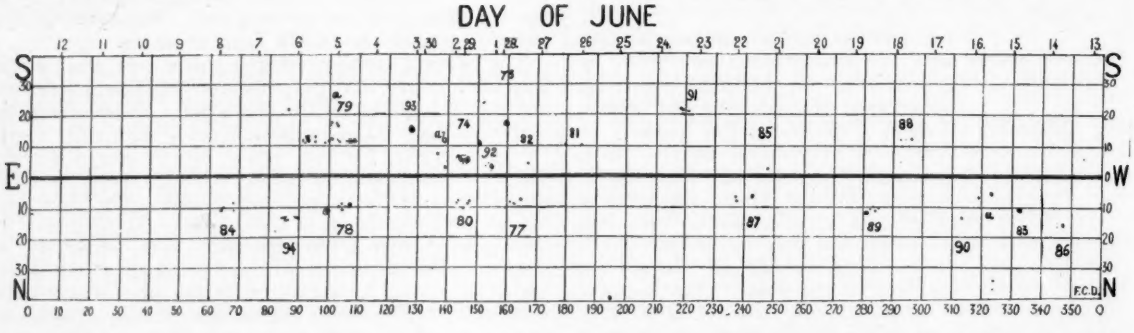
tion, playing somewhat the part of the particles of dust which brought about such beautiful and weird sunsets after the great Krakatoa eruption of 1883. The sun itself was barely 15°.5 below the London horizon on July 1. When this is considered, and compared with the tricks played by our atmosphere when in a highly refractive state, it does not seem so very surprising that we should thus be favoured sometimes with an abnormally brilliant summer midnight sky. Of course, the phenomena known as aurora borealis or northern dawn has really nothing to do with dawn, whilst this light, though certainly not auroral, was truly due to the northern dawn. Or, for a capital bit of Hibernism, that which is called aurora really is not, whilst this which should not be called aurora really is.

Solar Disturbances During June, 1908.

THE chart is constructed from the observations of J. McHarg, A. A. Buss, and F. C. Dennett, compared with drawings by A. Mee and E. W. Edwards. There has been a slight decrease in activity. The longitude of the central meridian on June 1, at noon, was 155° 24′.

Nos. 73, 74, 77, 78, and 79 are repeated from the chart for last month.



No. 74*a*.—A pore *following* the larger spot, seen only on June 5.

No. 74*b*.—Another pore *north following* No. 74, only seen June 5.

No. 79.—Was visible May 30 until June 10.

No. 79*a*.—A group 50,000 miles in length developed parallel to No. 79, but farther south, on 5th, the maximum diameter of the leader reaching 10,000 miles, 5th-11th.

No. 80.—Showed as tiny penumbraless pores on May 31; two pairs of spotlets 37,000 miles apart June 1; two pores at quite a different angle June 2-3.

No. 81.—Two pores on 1st, 37,000 miles apart, in area of No. 63, only one 2nd.

No. 82.—A pore seen only on 3rd.

No. 83.—A spot 10,000 miles in diameter near by the position formerly occupied by No. 70. 9th to 21st.

No. 83*a*.—A spot and pore 41,000 miles apart on 13th, only a pore remaining until 15th.

No. 84.—A very active group of pores 66,000 miles in length, the rearmost being largest, broke out on 10th, seen until 14th.

No. 85.—A small spot seen on 15th, north of a faculic disturbance; a close pair 18th. Only one when last seen, 19th, but on 20th a greyish pore appeared just 5° south of its place.

No. 86.—An evanescent pore, seen only 15th.

No. 87.—On 16th two spots near the limb, the smaller *following*, 17th-18th a larger spot with two smaller ones *following*, which died out. When last seen, on 23rd, a little pore had a larger one close behind it a little farther north. The group reached 44,000 miles in length.

No. 88.—Three minute pores nearly in a line, only seen 18th-19th.

No. 89.—On 19th, a group of pores developed near the central meridian, the most northern spot attaining a maximum diameter of 14,000 miles on 20th, when the length of the group reached 44,000 miles. Last seen on 21st.

No. 90.—A one-day pore, seen only 19th.

No. 91.—A group of spots and pores broke through on 22nd, close to the central meridian, the largest spot became 12,000 miles in diameter, and the length of the group 36,000 miles, near the western limb on 29th.

No. 92.—A spot, 14,000 miles in diameter, forming the preceding portion of No. 74, returned on 23rd. Alone until 28th, when a pore had developed to the south. On 30th pores almost encircled it, but from July 1 till 4th none of the small fry were seen.

No. 93.—A fine spot, 22,000 miles in diameter, alone, June 24 until July 6.

No. 94.—Tiny penumbraless pores amid faculæ on June 28, two larger pores, with minute specks between, 30th; on July 2 and 3 the spots were larger, the length of the group increasing from 50,000 to 65,000 miles. Only grey pores, marking the rear of the group, left on July 6.

LEWIS'S SCIENTIFIC CIRCULATING LIBRARY.—The periodic publication of the catalogue of Lewis's Medical and Scientific Library, the latest edition of which has just reached us, is an event of first-class importance to all who wish to keep in touch with current scientific literature. The multiplication of editions, and the rapidity with which the text-books in some subjects become obsolescent, makes it imperative that those engaged in research work should keep in touch with all that is published; and this can hardly be done without the assistance of a library which specialises, as Lewis's does, in scientific literature. The range of subjects covers completely all the branches of medical and surgical science, and embraces also astronomy, botany, chemistry, electricity, engineering, geology, natural philosophy, philosophy, sociology, voyages and travels, and zoology. New books and new editions are available to subscribers.

CORRESPONDENCE.

Falling Meteorites.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—I have been reading an interesting account, in a recent number of a popular magazine, of an incident witnessed a short time ago by the officers of a vessel in mid-ocean. The narrator describes the wonderful sight of an immense meteorite, which fell from the sky directly towards the vessel, falling into the sea a few feet away, with a mighty splash. As it advanced towards them there was heard the noise such as might be expected would be caused by so large a mass in rapid motion. Can any of your readers inform me as to what this noise may have been? For considering that the meteorite would probably be moving at the rate of several miles a second, straight towards the observers, one would conclude that its approach would be in perfect silence, the first audible symptoms of its arrival being the splash as it fell into the sea. Surely no sound caused by its motion through the air could reach the ear before the meteorite itself?

In the case of a flash of lightning advancing head on, the resultant thunder peal would resemble a phonographic record reproduced backwards, the first part of the crash being caused by the last part of the flash, and so on, backwards, ending, as is so often the case, with a louder roar corresponding to the more forcible explosion at the beginning of the flash.

While writing to you, may I ask also for light on the following curious incident during a very violent storm witnessed recently in the Eastern Provinces? Almost immediately following a very bright flash there was a noise not much louder than a pistol shot, immediately succeeded by a tremendous crash. Several heard it, and noticed the peculiar little preliminary noise.

Yours, etc.,

Capetown. T. BLATHWAYT.

The reply to the first query is that:

[The sound of falling meteorites is often heard before the objects are seen. This is because they fall with great slowness in comparison with planetary velocities. The last meteorite which fell in England was that of March 14, 1881, and Professor Herschel computed that its velocity on striking the ground was 412 feet per second. Now, sound travels at the rate of about 1,100 feet per second, whence it is evident that sound waves may reach observers before the meteors occasioning such sounds are really seen to fall.

It is evident that from the depth to which meteorites penetrate, they must have lost their celestial speed long before arriving at the earth's crust. Planetary attraction and atmospheric resistance have the effect of checking the ordinary velocity of shooting stars and meteorites, and the latter finally descend to the earth's surface very slowly in nearly vertical paths.

In regard to the latter part of our correspondent's letter, Mr. W. Marriott writes:—

I have on more than one occasion heard thunder somewhat similar to that described by Mr. Blathwayt—first a faint, sharp noise, then a tremendous crash.

Lightning takes the path of least resistance, and so its course may apparently be very erratic. By mentally noting the time interval between seeing the lightning and hearing the thunder we can estimate the distance of the flash. If the interval is five seconds, then the flash is about a mile away. If the lightning takes a variable path, we first hear the thunder from that part of the flash which has come nearest to us, and last of all that which was farthest from us, although it might have been the commencement of the flash. This accounts for the variations in the intensity of the sound of the thunder and also of its rumbling character.]

A Portable Telescope.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—In case any of your readers might find it useful, I send you particulars of a new form of telescope I have lately made. It is composed of an object-glass of 13 or 14-inch focus, and one of Watson's small "pencil" telescopes, which I use as the eyepiece to the object-glass; the result thus differing in construction from an ordinary telescope by the addition of an extra lens in the shape of the "pencil" telescope object-glass. By this means one can have any power, varying from 8 to 21 or so, by merely pulling out more or less the different tubes of the two telescopes. If you require a low-power with large field, and a short length of telescope, you pull out to some distance the tubes of the "pencil" telescope forming the eyepiece, and push in the main tubes, or *vice versâ* for a high power. By this way you lose no light in changing from a low power to a high, as in the case of the pancratic telescopes, and the light lost originally by the insertion of the extra lens is almost unnoticeable. You have by this simple arrangement in one instrument a variety of powers and ranges suitable for different occasions. It can also be used conveniently as a microscope for examining insects, etc., settled upon plants within a yard of the eye, without having to go so near as to disturb them, thus seeing them highly magnified under natural conditions. Then if desired, it is an easy matter to separate the "pencil" telescope and use it independently as a powerful little glass (of 11 diameters or so) which will go into a waistcoat pocket. By combining it with a larger object-glass you have a range of power from 8 to 30, or more at will. At its lowest power my instrument is 13 inches long, and at its highest only 18 inches.

Yours, etc.,

Capetown. T. BLATHWAYT.

ASTRONOMY.

By CHARLES P. BUTLER, A.R.C.Sc. (Lond.), F.R.P.S.

Radial Velocities of Second and Third Class Stars.

DURING the years 1903-1907 Professor F. Küstner and Dr. W. Zurhellen have been engaged at the Bonn observatory in systematically determining stellar radial velocities, and have obtained photographic spectrograms of nearly all stars of the second and third spectral classes down to the fourth visual or fifth photographic magnitude, using the Repsold-Steinheil refractor of 30 cm. aperture and 5·1 metres focal length. The spectrograph, by Töepfer, Potsdam, has three 60° prisms of heavy Jena flint, adjusted at minimum deviation for $H\gamma$, and a camera lens of 30 mm. aperture and 361 mm. focal length. The spectrum is sharply defined from λ 4150 to λ 4500, and at $H\gamma$ the linear dispersion is about 15·2 tenth metres per millimetre. Automatic control for constant temperature is provided, and every care taken with the adjustment of the comparison spectrum, in the majority of cases this being the iron arc diffused through a ground glass screen. Tables are given showing the resulting radial velocities of 99 stars, fifteen of which were previously known to show variable motion; in addition three others, δ Tauri, ϵ Bootis, and μ Pegasi, have been suspected of variation. The probable error of a single plate is computed as $\pm 0{\cdot}64$ km. per sec., and as the whole series consists of some 7500 measures of 44 different spectrum lines, it will be possible to obtain good determinations of their wave lengths and their dependence on the stellar type. Dealing with the corrections to be applied for errors of absolute wave length, Professor Küstner criticises the customary plan of using comparisons of sun, moon, or planet spectra, and thinks any comparisons should be from point sources as similar as possible to the stars themselves. Experiments are being made to this end by photographing the small starlike isolated mountain peaks on the moon's terminator which appear to indicate that they may provide the requisite light source for this work.—(*Astrophysical Journal*, Vol. 27, pp. 301-324. June, 1908.)

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Spectrum of the Chromosphere, January 3, 1908.

An account has previously been given of the excellent pictures of the Corona obtained by the Lick expedition to Flint Island for the last total solar eclipse on January 3, 1908. A recent article by Professor Albrecht gives the additional news that several of the spectroscopic results were also very satisfactory. One of the chief lessons taught by recent eclipse records is that the chromosphere spectrum should be photographed with as large dispersion as possible, to separate the numerous close pairs of spectrum lines, and with a large solar image, to obtain measurable values of the heights of the various layers of the solar atmosphere. One of the chief spectrographic instruments used was specially designed for this work, consisting of a series of three 60° prisms with a circular aperture of $2\frac{1}{2}$ inches, and a camera lens of 60 inches focal length. The entire spectrograph was mounted so that the prism edges could be adjusted parallel to the tangent to the disappearing crescent of the sun's limb. Immediately in front of the plate was a slit $\frac{1}{16}$ inch wide, permitting the central section only of each crescent to fall on the photographic plate. During the exposure the plate was moved uniformly about $\frac{1}{16}$ inch per second in the direction of the width of the slit. The linear dispersion of the spectrograph was such that from λ3700 to λ5300 occupied about 13 inches. The exposure at beginning of totality was spoilt by rain, but another was obtained extending from 15 seconds before the end of totality to 15 seconds after the end of totality. Hundreds of bright lines are recorded on this plate, showing the thickness and location of the corresponding vapour strata, and their changes into dark lines as the photospheric surface was uncovered by the moving disc of the moon. We shall await with interest the results of the detailed reduction of this record.

Good Corona spectra were obtained with one-prism spectrographs of small dispersion, and a large quartz spectrograph also gave successful results for the region λ3200 —λ5100.—(*Journal, Royal Astronomical Society*, Canada, Vol. 2, pp. 115-131, May-June, 1908.)

New Series of Photographic Star Charts.

There are many workers who feel the need of a star chart somewhat beyond the usual hand-drawn ones showing stars down to the sixth or seventh magnitude, and who cannot afford the elaborate copies issued by the various sections of the Astrographic Chart. To these the invitation recently issued by Professor Johann Palisa, the minor-planet specialist at the Vienna Observatory, will probably be welcome. He has been using copies of the stellar photographs taken by Dr. Max Wolf, of Heidelberg, and finds that they have so facilitated his work on faint stars that he estimates any particular investigation to occupy only one fourth the time previously occupied. By arrangement with Dr. Max Wolf, he has arranged for the publication (by photographic copying) of a number of these Heidelberg plates, provided with a réseau of degrees for facilitating the identification of the stars. The scale will be $1° = 36$ mm., and every map will contain 50 square degrees. By comparison with the faintest stars seen with the Vienna refractor it appears that the charts will show all stars down to the 14th magnitude. For such an original series of maps the price is very reasonable, 30s. for the series of 20 charts if ordered before December 31, 1908. Further particulars may be obtained from Herr Prof. Johann Palisa, Vienna XVIII., Türkenschanzstrasse 17.

Halley's Comet.

In preparation for photographic and visual search for this approaching comet, Dr. J. Holetschek has prepared a series of ephemerides based on three different times of perihelion passage. These indicate that the comet may be expected to be passing in a westerly path through the region about 5 degrees north of α Orionis (Betelgeuse) during the coming autumn and winter, its computed magnitude varying from 18·2 on 1908, October 2, to 17·1 on 1909, March 1.

Bright Beads on Saturn's Rings.

Professor W. H. Wright, criticising the explanation suggested by Barnard to account for the bright beads or knots seen on the rings of Saturn during the recent opposition of 1907, thinks that Barnard's view can only apply to the inner crape ring, and that, from Barnard's own observation of the eclipse of Japetus, it is difficult to understand how any light can be transmitted through the denser parts of the ring. Professor Wright then discusses the old explanation of the phenomena propounded by Bond, who considered the system as opaque, and the outer beads to be the edges of the two bright rings seen through the Cassini division. Bond's theory of the inner pair of beads appears weak, as the assumption of a division between the middle and crape rings does not agree with Barnard's modern observations. If now Bond's explanation of the outer beads is correct, it is evident there will be a definite relation between the width of Cassini's division, the thickness of the ring system, and the position of the beads. Professor Wright computes this relation, using the Saturnian constants determined by Aitken at the Lick Observatory, and finds that it shows a fairly satisfactory agreement with the observed facts. If confirmed the method should provide an independent means of determining the thickness of the ring system. Barnard thinks that the idea of intrinsic luminosity of the rings is not in keeping with the physical constitution of the rings, but Wright believes it not unlikely that in the aggregate there may be sufficient collisions, friction, &c., between the minute bodies to give rise to the feeble luminosity observed over the surface of the two dense rings, and in the knots.

BOTANY.

By G. MASSEE.

Agaves at Kew.

AN attempt is made in the *Kew Bulletin* to correct some popular misconceptions relating to the blooming of Agaves. The collection of Agaves at Kew is exceptionally large; and there are nearly always some of them in flower. The popular idea that the "American Aloe" (*A. americana*) flowers only once in a century is a myth; the flowering of these plants is quite a common occurrence at Kew. The age at which an Agave will bloom depends to a great extent upon the conditions under which it has grown; under very favourable conditions it may flower when ten years old; on the other hand if placed under unfavourable conditions it may take 25, 50, or 100 years, or it may never flower at all. Some species of Agave are flowering in the Royal Gardens at the present moment.

Origin of Yeast Plants.

There has been much controversy respecting the origin of Yeasts, some authors contending that they are entities, whereas by others they are considered as phases in the development of higher fungi. Recently Viata and Pacottet announced that *Gloeosporium nervisequum* gave origin to a yeast. G. Bonnier describes in *Comptes Rendus* his attempt to corroborate this statement. After eight months' growth of a pure culture on various nutrient substances, no formation of a yeast-like body could be detected, although the characteristic conidia and pycnidia of *Gloeosporium* was produced, and the conclusion arrived at is that the statement made by Viata and Pacottet arose from the presence of some impurity having gained access to their cultures, and, further, that yeasts must be regarded as autonomous plants.

Fusion of Nuclei in Pyronema confluens.

P. Claussen describes in *Ber. Deutsch. Bot. Gesell.* his investigations, and finds that the nuclei do not fuse in pairs in the ascogonium, as stated by Harper. The male nuclei after passing from the antheridium into the ascogonium do not fuse with the female nuclei until they pass into the asci, where fusion for the first time takes place. The author supposes that this condition of things will hold good in all ascomycetous fungi, and that it represents a belated sexual fusion between male and female nuclei.

An Overlooked Malvastrum.

Mr. T. A. Sprague describes in *Gard. Chron.* a mallow that has been cultivated in Britain for, at least, a century, but which up to the present has remained undescribed. The author's statement that the species of *Malvastrum* are extremely critical perhaps accounts for this oversight. Henceforth, the plant will be known as *Malvastrum hypomadarum*. The plant is a shrub, two to three feet high, bearing large pink flowers.

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CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

The Origin of Atmospheric Ozone.

IN a recent issue of the *Comptes Rendus*, MM. Henriet and Bonyssey give the results of their daily experiments on the variation of the proportion of ozone in the air, and the deductions drawn from them. Finding that an increase in the proportion of ozone is accompanied by a decrease in the amount of carbon dioxide, they infer that, since a reduction of carbon dioxide below its normal amount must be due to the introduction of air from high altitudes, ozone must also be derived from the same source. The maximum proportion of ozone is present when the wind is in the west and south-west, and the minimum with an east wind, whilst the reverse is the case with carbon dioxide. More air from high altitudes is thus brought down by westerly and south-westerly winds. Rain has a similar effect, for it increases the proportion of ozone and lowers that of the carbon dioxide. Solar radiation increases the amount of ozone, but does not affect the carbon dioxide. The proportion of the latter rises, however, when mists or fogs are present, owing to their preventing the diffusion of gases from the soil which contain carbon dioxide. The general conclusion arrived at is that the formation of ozone in the air is due to ultra-violet solar radiations at high altitudes, while its occurrence in lower strata is to be attributed partly to wind and partly to rain. Some ozone is also formed by solar radiation, even in the lower strata in clear weather.

Bacterial Oxidation of Carbon.

In exposing carbonaceous substances, such as charcoal, peat, or lampblack to the air, oxidation slowly takes place, with the liberation of carbon dioxide. This phenomenon has been shown by Mr. M. C. Potter to be the result of bacterial action, the gas being invariably evolved when the previously sterilised material was subjected to the action of pure culture of a *diplococcus* obtained from garden soil. The proportion of gas evolved increases with a rise of temperature up to a certain point, but the oxidation ceases when the thermal death-point of the microorganism is reached. There is also no evolution of gas from material so dry as not to permit of the growth of the bacteria. The oxidation is accompanied by a slight but easily detected rise of temperature, and it is pointed out that this may play an important part in the spontaneous combustion of coal, and possibly have a dangerous effect upon explosive gases. In Mr. Potter's opinion, the disintegration of coal when stored is to be attributed, in the main, to bacterial oxidation, whilst, on the other hand, these microorganisms are a valuable agency in rendering carbon available for plant life without previous combustion.

Ramie as a Textile.

Prior to the year 1900 no fewer than seven firms ruined themselves in attempts to popularise ramie in this country, the total loss of capital being over £250,000. In Germany some of the attempts have been attended with more success, partly owing to the use of cheaper labour in the preparation of the fibre, but mainly owing to the public's accepting more readily a novel material. Undeterred by the experience of their predecessors, there is once more a ramie company in this country, and there is stated to be a steady and increasing demand for their fabrics, especially for export to India and the Colonies.

The commercial fibre known as *ramie* or *China grass* is prepared from the bast fibres of the stalks of the stingless nettle, *Boehmeria nivea*, which has been cultivated from time immemorial in China. The bast is stripped from the stalk by hand-labour in China, and by machinery in Europe and America, and it is owing to the difficulty of obtaining an efficient decorticating machine, which would enable the product to compete in the market with linen and cotton, that ramie has not become more generally used.

The crude fibre is characterised by its great strength—about three times that of flax or cotton—while the "degummed" fibre prepared for spinning possesses a high degree of lustre.

The appearance of the fibre under the microscope is very characteristic, the cell-walls being very thick and folded inwards, so that viewed from one side the central canal or lumen appears as a narrow line. In composition ramie resembles linen and cotton, in consisting chiefly of cellulose, and like them can be effectively mercerised. Its chief drawback as a textile material is that it is somewhat harsh to the touch as compared with linen, though this is less noticeable in the finest fabrics. It is also considerably dearer, but the difference in price is more than compensated by its lasting qualities.

GEOLOGY.

By EDWARD A. MARTIN, F.G.S.

Diatomaceous Earth of Maryland.

THE Maryland Geological Survey has issued a report on the Physical Features of Calvert County, and the geology of the county is dealt with with accustomed thoroughness. The report is full of information of use to the agricultural classes, and although the book runs to 227 pages, it is evident that there is much more in the county to be studied in detail before the geology can be regarded as complete. There is an interesting reference to the diatomaceous deposits of the Calvert Formation (Miocene), which is well developed at Fairhaven. It has been worked for many years at Lyons Creek. The total greatest thickness of its three zones is about 62 feet, and contains large numbers of *Phacoides* (*Lucinoma*) *contractus*. When fresh it is greenish in colour, but on exposure changes to buff or almost pure white. It is referred to as useful in water filters, as an excellent base for polishing powders, and as valuable material for packing in steam boilers, owing to its bad conductivity of heat.

Quaternary Myriapods.

Geologists interested in the Myriapods will like to note the issue of a Bulletin of the University of California on the Quaternary Myriapods and Insects, by Fordyce Grinnell, jun. The specimens described were obtained during the exploration of the limestone caves of Shasta County, Cal., and from the asphalt beds near Los Angeles. The resemblance to modern species is remarked upon, showing the great length of time required to effect any change. The drawings are not quite up to the usual mark which characterises these Bulletins. This is to some extent no doubt due to the imperfection of the material.

Cambrian Formations of the Cordilleras.

Mr. C. D. Walcot has published in two parts of the Smithsonian Miscellaneous Collections an account of the nomenclature of some Cambrian formations in the Cordilleras, and of the Trilobites found in the American Cambrians generally. The Cordilleran formations are apparently almost virgin soil for the geologist, and Mr. Walcot has been under the necessity of adopting new names for the various deposits he has studied. The Cambrian rocks in the area traversed measure several thousands of feet thick, although the full extent of them it is not possible at present to estimate.

METEOROLOGY.

By WILLIAM MARRIOTT, F.R.Met.Soc.

Climate.

MR. ROBERT DE COURCY WARD, who is Assistant Professor of Climatology in Harvard University, U.S.A., has just issued a book entitled *Climate, Considered especially in Relation to Man* (London: John Murray, 372 pp.; 6s.). The author states that he has not attempted to present any very new or original material, but has aimed to co-ordinate and set forth clearly and systematically the broader facts of climate in such a way that the general reader, although not trained "in the technicalities of the science," may find it easy to appreciate them. The Introduction is a condensed synopsis of the first six chapters of Hann's first volume "Handbuch der Klimatologie," with the addition of some other matter. Chapter I. gives a sketch of the classification of the zones. Chapters II. and III.

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give a summary of the general climatic types which result from the control of land and water, and of altitude, over the more important elements of climate. Chapters IV.-VI. give an outline of the climatic characteristics of the zones in a simple and vivid form, with the least possible use of tabular matter. In Chapter VII. the attempt is made to give a survey of some of the relations between weather and climate and a few of the more important diseases. Little information on this subject is readily accessible to general readers. The life of man in the tropics, the temperate zones, and the polar zones is considered in Chapters VIII.-X. The final chapter, on changes of climate, deals with historic and periodic, and not with geologic, changes. The last phase of the subject has been fully discussed in many books; while the former, which are of more interest to most persons, have received much less attention.

Colour of Lightning.

Mr. C. E. P. Brooks, of 3, Roseleigh Avenue, Highbury, N., has sent the following notes on the colour of lightning:—

June 3.—During the night a heavy thunderstorm occurred. I only observed sheet lightning; its colours were white, blue, and orange—mostly a first flash of orange and a subsequent one of white; less often a first of white, and subsequent one of blue. The thunderclaps were unusually prolonged, lasting occasionally more than 30 seconds

June 4.—Orange and blue lightning.

July 3 (11 to 11.15 p.m.).—Very vivid blue lightning, but only the edge of the storm touched us.

July 3 (midnight to 2 a.m. 4th).—A heavy storm passed right over us. The lightning was a paler blue than in the previous storm.

Tercentenary of Evangelista Torricelli.

In connection with the celebration of the tercentenary of the birth of Evangelista Torricelli, an exhibition will be held at Faenza from August 15 to October 15, 1908. Included in the programme and associated with an international section for physical apparatus, in celebration of Torricelli, a prize of 2000 lire is offered for an instrument in connection with meteorology or physics of the earth. The instrument must be exhibited and show real novelty, either in its principle or in its application of a principle already known. Further particulars may be obtained on application to Dr. W. N. Shaw, F.R.S., Meteorological Office, 63, Victoria Street, London, S.W.

ORNITHOLOGY.

By W. P. PYCRAFT, A.L.S., F.Z.S., M.B.O.U., &c.

The Darwin-Wallace Celebration.

ON July 1 the Linnean Society celebrated the greatest event in its history—the jubilee of the presentation of that epoch-marking theory, the origin of species. This illuminating theory, there is scarcely need to remark nowadays, was conceived, independently, by Charles Darwin and Alfred Russel Wallace. And they first communicated this wonderful discovery in the form of a dual paper under a common title, "On the tendency of species to form varieties, and on the perpetuation of species and varieties by means of natural selection." The tremendous consequences of this communication all the world is familiar with. Ornithology, no less than other branches of zoology, received a rich endowment thereby. Darwin's work in this connection stands where he left it. Wallace's contributions have been, in some respects, less stable, since few now accept his ruling on the question of Sexual Selection, or his theories of the evolution of nests and the coloration of birds' eggs. Nevertheless, he has done splendid work, and received a most touching welcome at the hands of the great gathering of distinguished men which was brought together on Wednesday, July 1, to celebrate the occasion.

Woodchat in Cheshire.

Mr. J. M. St. John Yates, in *British Birds* for July, gives an account of a pair of birds which he saw on May 2 on the River Dane, near Congleton, Cheshire, which he is certain were woodchats—probably male and female. As he had them under observation for about fifteen minutes, and, moreover, knows the red-backed shrike well, there is little doubt but that his identification is correct.

Hoopoe in Shropshire.

British Birds (July) contains a short note by Mr. H. E. Forrest to the effect that a hoopoe was seen by Mr. G. H. Paddock in his garden in Wellington, near Salop, on May 29, when the unfortunate bird was being mobbed by sparrows and was eventually driven away.

Rose-Coloured Pastor in Caithness.

Major A. Huges-Onslow writes to the *Field*, July 11, recording the fact that, on July 2, he saw, on some sandy ground near Reay, Caithness, a bird which he identifies as a rose-coloured pastor. From the striking and peculiar coloration of this bird we may take it that the identification was correct.

Sand Grouse in Hampshire.

In the *Field*, July 18, Mr. Basil Roper gives a short account of two birds which he saw flying over his garden at Havant, which, as the editor of this magazine points out, must have been sand grouse, though Mr. Roper at the time supposed them to be South African "pan-partridges," of which he has shot large numbers in Africa.

The Large-Billed Reed-Bunting in Kent.

At the last meeting of the Ornithologists' Club Mr. M. J. Nicoll exhibited a fine male specimen of the South European large-billed reed-bunting (*Pyrrhuloides palustris*) which had been killed on Romney Marsh on May 26. This makes the first record of this species for Great Britain.

PHYSICS.

By PROFESSOR A. W. PORTER, B.Sc.

Condensation of Actinium and Thorium Emanations.

FROM the experiments of Rutherford and Soddy it is known that at a temperature of -150° C. radium emanation condenses, and that it evaporates again at a temperature only a few degrees higher. The behaviour of thorium emanation was shown by them to be considerably different. At -120° C. it condenses in part; but a temperature of -150° C. must be reached in order to completely condense it; and there were, moreover, other differences. These differences were attributed to the great differences in the number of particles present in the two cases.

Mr. S. Kinoshita has now made a very complete set of observations on both thorium and actinium emanations. These experiments present considerable difficulties, especially in the case of actinium, the emanation of which falls to half value in less than four seconds. The results of these experiments are exceedingly interesting, for it turns out that there is practically complete similarity (almost identity) of behaviour between the two emanations, as the following selections from the table of results show.

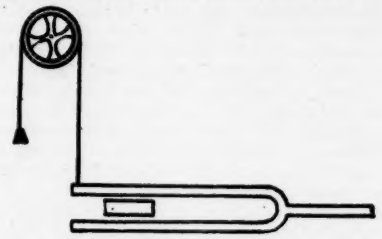
Percentage remaining uncondensed.	5%		50%		95%	
Pressure in mms.	Act.	Th.	Act.	Th.	Act.	Th.
120	−149·8	−149·1	−140·5	−138 3	−126·2	−1.0·5
180	−154·0	−152·3	−145·8	−144·0	−133·0	−130·5
760			−153·0	−152·8	−143·2	−144 3

The similarity between the two emanations in respect to condensation is very remarkable. The small differences even may be perhaps attributable to uncontrollable sources of error. Another point of interest is the support it gives to the pioneer experiments of Rutherford and Soddy on thorium emanation. There is a tendency to suppose that these experiments may be valuable as indicating very roughly the character of radioactive phenomena; but at the same time to hint that it is work that all wants doing

over again before reliance can be placed upon it. This confirmation of the result that the amount of condensation increases with lowering temperature in the case of thorium emanation is therefore of importance. No test has yet been made deciding as to what the condensation phenomenon really is. Is it analogous to the condensation of steam into water or ice; or is it a case of absorption, *i.e.*, similar to the condensation of water-vapour upon glass? The behaviour in the case of thorium and actinium seems to be most in agreement with the latter phenomenon.

Production of Rotary from Vibratory Motion.

The following simple experiment illustrates the continuous production of rotary motion from non-rotary motion. A thread is attached to an electrically-driven tuning-fork (see illustration), passes over a pulley, and is then loaded with a small weight. If the weight is properly chosen the pulley spins round when the fork is sounding.



The action is much the same as in the spinning of a "diabolo," or in setting a wheel in rotation by a horizontal motion of the hand on the rim during the forward motion of the hand, the hand being raised slightly during its backward motion.

Ethereal Transfer or Action at a Distance—Which?

"It may seem as if the real antithesis was between the postulates of a connecting medium, on the one hand; and of action at a distance across empty space on the other; and as if Lord Kelvin were in favour of the latter view. I do not, however, think it would be fair to attach to him that responsibility. I think it was more a matter of practical politics with him than a philosophical conception. . . . He did speak at times, however, as if immediate action across empty space would be logically satisfactory to him and quite good enough as an explanation—the only question being, was it the true one? To me, I confess that any such philosophic scheme must necessarily be a cold and merely descriptive account of material activity—that it must necessarily fail to go to the heart of the matter or to constitute what may more reasonably be called "explanation." The conception of forces acting according to a specified law of distance is capable of yielding dynamical results truly, but not of explaining them. Explanation, however, is never ultimate; so it may be that the process contemplated, and in his last years energetically worked at, by Lord Kelvin is an intermediate stepping-stone, which must be taken in order to cross to some more stable resting place beyond; just as has happened in the case of gravitation."—(Sir O. Lodge, Presidential Address to the Faraday Society, May 26, 1908.)

ZOOLOGY.

By R. LYDEKKER.

Armour-clad Mammals.

FOR some years past evidence has been gradually accumulating to the effect that in the ancestors of several groups of mammals the skin was protected by a bony or horny armour. The latest addition to the list of animals retaining vestiges of such an armour is the fox, in whose skin a German investigator has detected a structure indicating the presence in the ancestral forms of an imbricating panoply of scales arranged like the tiles on a roof. Under the microscope the skin displays very clearly a pattern representing the implantation of such a scaly covering; while the mode of arrangement of the hairs lends further support to the evidence afforded by the structure of the skin. If these inductions be well established—and there seems little doubt that they are so—the fox carries about with him indisputable evidence of his descent from mail-clad ancestors, who in turn must seemingly have inherited their panoply direct from still earlier reptilian progenitors. Such progenitors were in all probability the mammal-like reptiles of the Trias of South Africa, from which the primitive, or creodont, carnivora of the Eocene Tertiary are almost certainly descended.

It would seem, however, that in other cases there was a fresh development of armour among early mammals long after their complete emancipation from the reptilian type. The primitive whales, or zeuglodonts, appear, for instance, to have been heavily armoured, probably to protect them from the breakers as they gradually adapted themselves to a pelagic life. Since, however, these primitive whales are now know to be the descendants of the primitive carnivora, they probably derived the rudiments of their armour from the latter, instead of, as has been supposed, developing it entirely *de novo*. That the structure of the skin of the fox should help us in deciphering the past history of whales is perhaps one of the most unexpected circumstances in natural history!

A Rare Turtle.

A very rare visitor to the British Isles was captured a few weeks ago, I believe on the coast of Scotland, in the shape of a fine specimen of the luth or leathery turtle. From ordinary turtles the luth, which grows to a very large size, is readily distinguished by the circumstance that the upper shell is composed of a kind of mosaic of bone, overlain by a horny skin, and quite free from the underlying ribs. The name of "luth" seems to be derived from the presence of a few longitudinal ridges, which have caused the upper shell to be likened to an ancient lyre. The species is the last survivor of a long line of extinct relatives. The previous representative of the species recorded from the British Isles appears to be one captured on the Dorsetshire coast some eighty years ago. Although less uncommon on tropical coasts, the species seems to be everywhere rare. In the exhibition galleries of the Natural History Museum it is represented by a cast of an enormous specimen captured a few years ago near Trivandrum on the Madras coast.

Extinct Lemurs.

Interest in the wonderful, and in several cases gigantic, extinct lemurs of Madagascar has been revived by the publication in the *Transactions* of the Zoological Society of a lavishly illustrated memoir on a magnificient series of skulls and other remains obtained by Mr. H. F. Standing. In certain marshes in Madagascar such remains occur in profusion and in a marvellous state of preservation; and it seems evident that the animals to which they pertained survived till a comparatively recent date, perchance to the time of the 17th century navigators. Whereas the largest of the modern lemurs—locally known as sifakas—do not much exceed three feet in height, with a skull of something like the same number of inches in length, certain of their extinct relatives were positive giants, one in particular having a skull quite a foot long. Another, it is suggested, may have been aquatic in its habits.

The Development of Dolichoglossus.

As a relative of the acorn-worm (*Balanoglossus*), the typical representative of a group which has strong claims to be regarded as not far removed from the ancestors of the vertebrates, the American *Dolichoglossus*, a native of certain portions of the mud flats on the Californian coasts, is a creature of extreme interest to the naturalist. We are, therefore, glad to welcome a paper by Mr. B. M. Davis on its early development and structure, published by the Californian University, of which we have been favoured with a

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copy. The paper, which is illustrated with a coloured picture of the orange-coloured creature in its burrow, is of too technical a nature for fuller notice in this Journal.

Papers Read.

At the meeting of the Zoological Society on June 16, Mr. O. Thomas described a collection of mammals from Northern China; an imperfectly developed sea-urchin formed the subject of a communication by Messrs. Ritchie and McIntosh; while Messrs. Minchin and Reid discussed the minute structure of calcareous sponge-spicules. Other papers included one by Dr. T. A. Chapman concerning certain butterflies, a second by Mr. Beddard on the frog *Rhinoderma*, a third by the same gentleman on the aye-aye, a fourth by Messrs. A. Porter on a blood-parasite of the mouse, a fifth on South African Microlepidoptera by Mr. E. Meyrick, and a sixth by Mr. A. G. Thacker on calcareous sponges from the Cape Verd Islands.

REVIEWS OF BOOKS.

ANTHROPOLOGY.

Primitive Traditional History: The Primitive History and Chronology of India, South-Eastern and South-Western Asia, Egypt, and Europe, and the Colonies thence sent forth, by J. F. Hewitt (London: J. Parker and Co., 1907, 2 vols.; 21s. net).—As will be seen from the title, the late Mr. Hewitt has attempted to solve an enormous problem, or, rather, series of problems, to which he brought to bear a remarkable amount of enthusiasm, energy, and erudition. It would require as great learning and much time adequately to review this compendium of facts and theories, neither of which the present writer possesses. In a book of this kind the value necessarily depends upon the reliability of the evidence. As Mr. Hewitt resided so long in India, and made a special study of the more recondite aspects of Indian lore, we may assume that in this part of the book the facts are correct, though all of his interpretations may not find favour with the less imaginative and more academic student. If, however, we turn to subjects outside of his Indian experience, we occasionally find that slips occur; for example, Neanderthal man is stated to have been a bow-using dwarf (p. 147), neither of which is true, so far as our knowledge goes. The author lays great stress on the doubtful question of pottery-making in palæolithic times; to grant it to Neanderthal man is going too far, but it is part of the author's argument that, spreading north-eastwards, their descendants, mixed with Finns, brought bow and pottery making into India, and "substituted Finn marriage of individuals for the village unions of the Indian Dravidians" (p. 150). We are told that the Northern hunters and the Finns worshipped the Great Bear, and the latter were the founders of the worship of the household fire (p. 152). The hypothetical pre-Ainu pottery makers of Japan "were apparently of the same race as the pigmy inhabitants of the caves of the Liesse and of underground Pict houses in Scotland (p. 149)! The following statement, "the Malays, who, in India, are the Mallis and Mons, the men of Malabar" (p. 574), does not commend itself to the ethnologist, but, as he speaks of the Kolarian races of South-Eastern Asia as the progenitors of the Malays (p. 7), he has evidently confounded Indonesians with Malays proper. Nor would any philologist agree that the world-wide interchange of *r* and *l* marks any people "as allied to the Finns, who in Greece changed the name of the Phrugyes, son of fire (*phur*), into Phlegyes" (p. 592). It would be hard to prove Finnish influence all over Oceania. These are examples of the reasons which lead one to be cautious about accepting statements that cannot be readily verified. Mr. Hewitt's object in writing the book was similar to that of his "History and Chronology of the Myth-making Age," and in both he has "tried to prove that one of the most reliable guides to the ascertainment of trustworthy knowledge of the sequence of the stages of progress made in the struggles of the pioneers of civilisation against chaotic barbarism is to be found in the history of the computation of annual time." He believes that the idea of God which underlies all religions of the aboriginal races of Asia and Europe and their descendants is that "He is the one all-pervading Will who rules all things, and who, as the measurer of time, was thought to ordain the seasons" (p. 4). The earliest method of year measurement that he has been able to trace is the division into north-east and south-west monsoons. These were ruled over by the storm-cloud bird worshipped in South India and by the Sumero-Akkadians and the Egyptians; later a five-day week was devised. Still, at a very early period it was observed that "The Pleiades began to set after the sun about the time when the north-east monsoon set in, and continued to set after it for thirty-six five-day weeks." This was the period when the Australians had not been severed from the Proto-Dravidian stock. These forest races of Southern India and the Indian Archipelago called themselves sons of the forest trees and the tree-ape. The inauguration of the year of forty stellar months of twenty-seven days, covering a cycle period of three solar years, each of 360 days, was inaugurated when the sun was in Cancer at the winter solstice (about 14,000-12,600 B.C.); it was the national year of the pastoral races. A modification occurred when "the emigrant southern tribes settled in Syria and Asia Minor, where they could not see Canopus and Argo. They there met with the hunting races of the North, who measured their year by the circuits round the sky of the sun, depicted in their mythology, as the heavenly reindeer hunted by the ruler of the storms, the hunting Orion. This star was made the year-star of the confederacy formed by the union of the southern farmers, whose year-star had been Canopus, with the northern hunters and with the Finn races." This new year, in which Orion led the Pleiades and their attendant stars round the Pole, was measured by three seasons, and was believed to be under the special control of the Great Bear, which superseded Canopus, the star of the ape, as the supreme ruler of the year. The age of the present sunwise circuits was apparently introduced with the Babylonian Zodiac framed after the sun entered Taurus at the vernal equinox, about 4,600 B.C. The second stage of Orion's year following that ending in the death of the sun-deer slain by the Great Bear's arrow, and that of the year ruled by the seven Great Bear's pigs driven by the Great Bear sow. The belief in boar god ruling the year was that dominant in the early neolithic age of Europe. It was essentially the age of pig worship. The pastoral races who succeeded the farming and fruit-growing sons of the pig, measured their year by thirteen lunar months of four weeks each and by the three-year cycle-year. In this age the Great Bear ruling star was looked on as the bed or waggon of the year god, which was drawn by the horse or sun-ass. But in this year of thirteen months the symbolism was somewhat varied. At this time the linga and yoni cult arose, and bees were looked on as especially inspired by God. The year beginning when the sun was in Aries at the autumnal equinox still survives among the Jews, who open their New Year's Day with blasts of ram's horns; and it was then that they offered their first-born to the fire or sun-god, a sacrifice which is commemorated in the story of Abram. In the eleven months year of the sons of the Ash-tree, the parent tree of the Bronze Age, the Great Bear was no longer the car or bed of the year-god, but the reins with which the horse is driven. The foregoing extracts and abbreviations will serve to give an idea of some of the problems attacked by Mr. Hewitt, and it is impossible to do more than this. Not only was his information obtained from literary sources, but he gained much from jungle tribes. "In the large tracts of forest and hill country in Central India explorers may practically live in the present day in all the successive historical ages, beginning with the early palæolithic down to the latest age of Vedic sun-worship, and in those developed from it by the schools of Hindu philosophy, and the latest forms of Jainism, Buddhism, and Sikh and Mahommedan Unitarianism. . . The descendants of all these races still retain in their memories endless stores of traditional lore, which they are very ready to tell to those who secure their confidence."

Savage Childhood, by Dudley Kidd (London: A. and C. Black, 1906; 7s. 6d. net).—This is a really delightful book, whose every page bears the stamp of authority, for the author shows an intimate first-hand acquaintance with his subject coupled with a restraint in matters of interpretation

which, while in no way robbing his pages of their charm, adds greatly to their scientific value, and to the confidence of his readers. "Only those," says the author, "who have studied Kafir children can realise how fascinating, and yet how difficult, the subject is. The children are so shy of the white man, and the parents are so unwilling, or so unable, to supply reliable information, that it is peculiarly difficult to enter into the *vie intime* of the children." And, again, "The children do not 'show off' before Europeans, and so it is as necessary to stalk them at play as it is to stalk wild animals in order to discover their habits." Like many others who have studied this subject, Mr. Kidd is strongly of opinion that the work of the missionary is by no means so beneficial as some would have us believe. He begins by robbing the children of their innocence by instilling prudish notions into their minds, while, in condemning certain customs of later childhood and puberty, he has brought about an increase in immorality. The chapter on Children's Fairy Tales is extremely interesting; one of these bears a remarkable resemblance to Uncle Remus's "Tar-baby," in which Brer Rabbit, Brer Tarrapin, and Brer Fox play so conspicuous a part. Thus it would seem that this story is of African origin; the rabbit, fox, and terrapin replacing the hare, the lion, and the tortoise; while the "Tar-baby" is replaced by gum-trees. No less interesting are the Appendices, wherein will be found a great deal of interesting matter of a more philosophical character. Finally, this is a book which should be carefully digested by all who are likely to have to do with the native races of Africa. As to the illustrations, they are, of their kind, perfect, and copiously distributed throughout the work.

BIOGRAPHY.

The Life and Letters of Herbert Spencer, by David Duncan, LL.D. (London: Methuen and Co., 1908; pp. 618; 15s.).—It was characteristic of Herbert Spencer's love of exact truth that he should have provided in his will for the publication of a biography of himself by his friend Mr. David Duncan, to complete and correct the impressions created by his own voluminous autobiography. Mr. Spencer, as his biographer explains, held that a man's estimate of himself is sure to err on the side of excess or defect. Vanity on the one hand, self-depreciation on the other, militate against a man's dispassionate estimate of himself. Discriminating readers of the autobiography would differ from the popular estimate of its author, as a man "all brains and no heart"; but because of this popular impression it is especially on the human element in his character that Mr. Spencer's present biographer wishes to insist. For Mr. Spencer, "like all the finer natures, shrank from parading the more attractive and lovable aspects of his character." Mr. Duncan has done his work well. As far as possible, needless repetition has been avoided, and the concluding years of his life, which the autobiography did not cover, have been more than adequately dealt with. One impression left by his early years, which in the autobiography seemed so curiously desultory and purposeless, is deepened by the biography. Mr. Spencer was, as it were, groping for the realisation of his own potentialities; and he himself speaks of "the seemingly futile part" of his life. His career is, however, throughout, lacking in dramatic incident. It is the record of mental development. It is to the history of his ideas, their genesis and development, his whole mental evolution in fact, that Mr. Spencer attached supreme importance. The momentous events in his career are the instants when some new conception of cause or effect in the relations of things was suggested to him. His dislike of leaving anything "with loose ends," to use his own phrase, is here exemplified by the summary which he made of "The Filiation of Ideas," written in 1898-9. In this curious and profoundly interesting mental autobiography he traces to the intractability and impatience of restraint that were characteristic of his childhood the origin of the distinguishing independence of judgment of later years—that mental detachment which, joined to an active constructive imagination and an inherent preference for thought over action, marked the philosophic temperament. Thus, from the "Essays on the Proper Sphere of Government," written in his early years, which illustrates that instinctive opposition to arbitrary control already mentioned, Mr. Spencer traces the first idea of a social organism, afterwards developed in "Social Statics." Here is displayed the conception of the evolution of everything in the moral, mental, and physical worlds, subsequently developed in the "Principles of Psychology," and again further defined and elaborated in the "First Principles." Probably few thinkers could trace in detail the orderly sequence of their own mental development as Mr. Spencer has done, in this summary of his life's work, and it forms a psychological document of absorbing interest.

PHYSICS.

The University Tutorial Press, Ltd., continues its issue of text-books suited to all grades of examination. In **A School Magnetism and Electricity,** by Dr. Jude (3s. 6d.), we have one of the most instructive elementary text-books that we have ever come across. Dr. Jude has a genius for the accurate presentation of facts and logic in an easily understood way. His discussion of so-called "free" and "bound" charges is much more satisfactory than the treatment in most advanced text-books. We recommend the book throughout. The new **Matriculation Light,** by Dr. R. W. Stewart (2s. 6d.), is a lucid account of the elements of Geometric Optics. Great attention has been paid in it to practical work. The diagrams are very numerous, and, in general, very instructive. Fig. 72, showing the positions of the images formed by successive reflections from a parallel slab of glass is, however, misleading. **A Matriculation Sound,** by the same author (2s.), is a very welcome addition, inasmuch as text-books on this subject are often scarcely satisfactory. Considering that the whole subject must be treated with scarcely a mention of a trigonometrical function, the difficulties of exposition are necessarily great. Dr. Stewart's large experience in exposition has enabled him to overcome these difficulties in a very satisfactory way. **The Higher Text-Book of Magnetism and Electricity,** by the same author (6s. 6d.), is a more ambitious effort. It is the second edition of a recast of an earlier text-book, the great advances made in recent years necessitating a complete revision. It is intended for final degree work. Elementary calculus is employed. In this second edition there is an extra chapter on the Electron Theory of Matter and Radioactivity, written by Mr. J. Satterly. It is not correct to say that "a charge of q electrostatic units moving with a velocity x is equivalent to a current of qx electrostatic units"; an examination of the dimensions will reveal the existence of error in this statement. The account in this chapter is, however, a very excellent one, though some statements are made too positively. Thus it is somewhat previous to state that the molecular weight of radium emanation is 221.

Theoretical Mechanics, by J. H. Jeans (London: Ginn and Co., 1907; 10s. 6d.).—The aim of the author is to provide a text-book founded on *physical* principles, leaving aside at first all mathematical developments and all practical applications. We believe this to be the correct line to take, and, consequently, in this respect, we heartily recommend the book that he has produced. The difficulty of treatment is progressive. The final chapter will, we think, prove too difficult for a beginner. Some knowledge of the calculus is assumed throughout. There is a large number of examples.

MESSRS. GALLENKAMP'S CATALOGUE.—From the excellently illustrated catalogue just issued by Messrs. Gallenkamp, of 19 and 21, Sun Street, Finsbury Square, the great progress which has been made during recent years in the construction of wax models to illustrate botanical processes and specimens on a large scale can be readily seen. The list of Smedley's models includes palæozoic seeds, cones, fern pinnules, algæ, fungi, bryophota, and vascular cryptogams. They illustrate the germination of seeds, the processes of insectivorous plants, as well as some of the invertebrate organisms. These models are not only popularly instructive, but are of great value for class teaching. Messrs. Gallenkamp's catalogue embraces also museum jars, show jars, and many useful aquarium appliances.

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MICROSCOPY

Conducted by F. SHILLINGTON SCALES, B.A., F.R.M.S.

(*Continued from page 172.*)

The Preparation of Microscopical Objects.

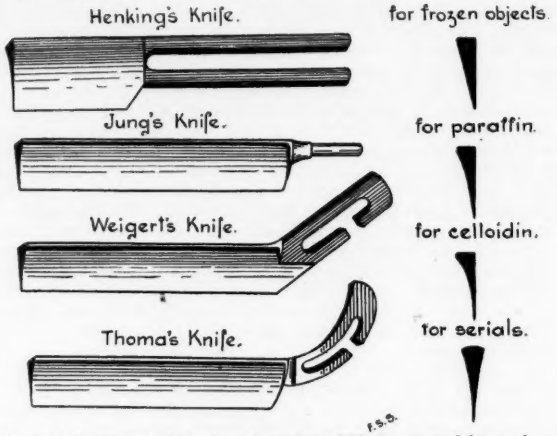
When quite dry and hard the blocks of paraffin are removed from their moulds and trimmed as already described. They can then be clamped in the microtome, but the best way is to affix them to square wooden blocks of suitable size. It is only necessary to dip the ends of the blocks beforehand into melted paraffin, and then, when required, to attach the paraffin blocks by slightly melting the opposed ends with a warmed knife-blade.

The actual cutting of the sections is a comparatively simple matter if all the preliminary details have been well and carefully carried out. Much depends on the edge of the knife or razor, and it must be confessed that the keeping of the edge in first-rate order is not an easy matter, whilst honing and stropping require no little practice.

The hones are best got from the makers of the microtome, and the best forms are known as Turkey, Belgian, or Bavarian hones, having, of necessity, a very fine grain. They must be of ample surface, say, eight or nine inches long by two inches wide, and as they are very soft they must be kept for the one purpose only, and scalpels, knives, or ordinary razors must never be sharpened upon them. A good hone will cost from 12s. upwards. The best lubricant is palm-oil soap made into a lather with water, and after use the oil must always be carefully wiped from the stone with a soft rag, or it will soak in and harden the stone so as to make it unfit for use. The knife should lie flat upon the stone concave side downwards, and for large knives their own weight is quite sufficient pressure. The motion should always be in a straight line, from left to right, and no circular movement is permissible, whilst the knife must, of course, on no account be sloped upon, much less turned upon, its edge. It is often a tedious operation to put an edge upon a dull or notched knife, but any attempt at hurrying the process only makes matters worse. If a "paper edge" is formed a little honing on the other or plane side is then necessary. An examination of the edge under a pocket lens, or even under the microscope, is often of service.

The strop is also best obtained from the makers, and must also be of ample size, but, above all, it must be taut. The ordinary leather strap used by barbers is a most dangerous instrument in unskilled hands, and there are few people who can use it satisfactorily even for the stropping of their own razors with which they perform their daily shave. One may remark in parenthesis that the usual practice with many people seems to be to hold such a strop slackly, and to stop the razor vigorously upon it, rolling the razor over each time upon its edge instead of its back, and then to complain of the frequency with which the razors require "resetting." The less paste there is upon the strop for microtome knives, the better, and the knife must always be stropped in the direction of the grain. Many strops are marked accordingly.

The accompanying illustration shows types of different knives. The Henking knife has only a short blade and is comparatively inexpensive; the Jung knife fits into a special clamp, and has a stropping handle; the Weigert and Thoma knives are specially designed to work at an angle, and are expensive, costing from 12s. to 35s., according to length of blade. The first two are the more easily sharpened, but each knife has its own holder to facilitate this, and to ensure as far as possible uniformity of angle. The section of the knife varies according to the class of work required of it, as shown in the illustration.



Types of Microtome Knives, and section of blades ground for various purposes.

The knife can be set square with the object to be cut, or diagonally to it. The former is necessary for cutting serial sections, and, as already explained, the paraffin block must in this case be carefully trimmed so as to have two of its sides parallel, and to have these sides parallel with the edge of the knife, otherwise the ribbon will run off crookedly if it runs at all. The knife when set square has a greater tendency to crush the sections. The knife when set diagonally is more suitable for difficult and uncertain objects, especially those which are large or very soft, or of varying consistency. The diagonal knife does not, of course, make actually a slicing cut—this is impossible—but by its position it reduces the angle of the section of the knife. For the diagonally set knife the object should have its sharpest angle, and not its edge, against the knife.

The position of the knife can be varied in yet another way, namely, by slightly altering its "tilt," in other words, by altering the relative height of the back and edge. The tilt is of some importance, but if excessive it is apt to break the sections and also is more liable to make them roll. It should be just enough to enable the edge to clear the section comfortably without scraping or vibration, and is generally rather less for hard than for soft objects. Serial sections require but little tilt, whilst celloidin requires a fair amount.

(*To be continued.*)

Microscopical Material.

By the kindness of Mr. T. C. Thrupp, of Haywards Heath, I am able to offer to such of my readers as care to apply for it, some moss capsules of *Mnium undulatum*, concerning which Mr. Thrupp observes: "The peristome of this plant is a light yellow, and is very beautiful and quite different to the moss previously sent" (see "KNOWLEDGE" for February, 1908, p. 47). "This plant is very common, but the capsules are infrequent

and require looking for. They are absent from some localities. I have some with nine or ten capsules in one perichaetium." Applications must be accompanied by a stamped, addressed envelope, and by the coupon to be found in the advertisement columns of this issue of "KNOWLEDGE."

Royal Microscopical Society.

June 17, 1908. A. N. Disney, Esq., M.A., B.Sc., in the chair. Mr. J. W. Gordon exhibited a lens for high-power microscopy, devised by himself and Mr. H. Fletcher Moulton, to obviate the use of the oscillating screen introduced some time since. Mr. Gordon claimed that the lens under proper conditions of illumination was capable of producing perfect images on the highest obtainable scale of magnification. At the meeting, a podura scale was exhibited by its aid under a magnification of 8,000 diameters. Mr. Arthur Skinner exhibited a small simple microscope, by Cary, only $4\frac{3}{4}$ inches high. Micro-slides, lent by Mr. A. Flatters, were exhibited, illustrating the structural parts of the chick at various stages of its development from about two days to four and a half days. There was also a series of slides of transverse sections of the embryo at the same stages. Dr. Hebb exhibited some excellent stereo-photomicrographs, sent by Mr. Wm. P. Dollman, of Adelaide. Mr. E. Heron-Allen read a paper, the joint production of himself and Mr. A. Earland, on "Cycloloculina," a new generic type of Foraminifera, which they had found on the shore of Selsey Bill. The paper was illustrated by a large map on which the localities where the specimens were collected were pointed out, a number of slides of specimens under microscopes and lantern slides being shown upon the screen. Mr. J. W. Gordon gave a *résumé* of his paper on an "Illuminating Apparatus for the Microscope," in which the light from a Nernst lamp was transmitted through a glass rod, the end of which nearest to the lamp is cut to a plane surface and finely ground; the other end has a polished surface, flat or lenticular in form according to the user's requirements. The apparatus was exhibited and its utility demonstrated to the meeting. A paper by Mr. E. M. Nelson, on *Corethron criophilum*, was read by Dr. Hebb. Mr. Gordon announced that the Council had made arrangements by which the Fellows could form sectional groups for the pursuit of the branch of microscopical study in which they were most interested. There would be meetings on Wednesday evenings, except on the nights of the ordinary meetings, and it was proposed to start work next session with three groups, one for the microscope section, one for bacteriology, and one for pond life.

Quekett Microscopical Club.

June 19. Mr. A. Earland exhibited and described a number of preparations of Foraminifera, among which may be noted a slide showing "triple isomorphism" in the Porcellanous type, *Cornuspira*, *Arenaceous*, *Ammodiscus*, and in the *Hyaline* type, *Spirillina*. A preparation showing isomorphism between an Arenaceous and a Hyaline form, *Globigerina bulloides*, d'Orb, and *Haplophragmium globigeriniforme*, Parker and Jones.

The Honorary Librarian, Mr. Alpheus Smith, was presented with a silver tobacco box and a sum of fifty sovereigns, subscribed by members in recognition of his 36 years' service to the Club.

A paper on "The Proboscis of the Blowfly, *Calliphora erythrocephala*, Mg.," a study in evolution, communicated by Mr. W. Wesché, F.R.M.S., was read. The paper, which does not lend itself to abstracting, will be reproduced, with illustrations, in the next issue of the *Journal Q.M.C.*

Orientating Small Objects for Examination.

At a recent meeting of the Royal Microscopical Society, Messrs. W. F. Cooper and L. E. Robinson exhibited a simple method of orientating small objects, which they have found useful in their work on Ixodidæ, where considerable difficulty is often found in fixing small objects temporarily in a suitable position for observation. A small bead of "Plasticine" is placed on a slide and slightly flattened, the object is then placed upon it, moved into a suitable position, and slightly pressed into the plasticine. A small cork is cemented with sealing wax to one end of an ordinary glass slide, and through this is run a glass-headed pin about two inches long, lying parallel with the surface of the slide. On the end of this pin is placed a small rectangular piece of cork which carries the plasticine. By revolving the pin the object can be rotated and observed through an angle of 180°. The apparatus is very simple, efficient, and inexpensive.

Notes and Queries

Hemiptera-Heteroptera, of Lancashire and Cheshire.—I have received from Mr. Oscar Whittaker, of 13, Lancaster Road, Birkdale, a preliminary catalogue of the Hemiptera-Heteroptera of Lancashire and Cheshire, reprinted from the Proceedings of the Lancashire and Cheshire Entomological Society, which will not only be of service to those who are interested in these comparatively neglected orders, but may perhaps stimulate others to add to the list by giving special attention to them.

The Theory of the Microscope.—Mr. Conrad Beck has kindly sent me a copy of the reprint of his Cantor Lectures, recently delivered before the Royal Society of Arts, on the "Theory of the Microscope," which deal with the theory of the microscope in a simple yet scientific way, and which few microscopists could read without learning something, and perhaps gathering suggestions which might be of service to them in their work. The first lecture deals with the optical construction of the instrument, and is on more or less familiar lines; the second lecture deals with the errors of lenses and their correction, and is a lucid exposition of the elementary principles underlying this most important subject, the mathematical treatment being but slightly touched upon; the third lecture deals with the errors of a microscope due to diffraction, and incidentally touches upon several of the points concerning which there has been no little debate and controversy during the last two or three years, wherein Mr. Beck follows the lead of Mr. J. W. Gordon; whilst the fourth and last lecture deals with the practical applications of theory, and is perhaps the most suggestive of the four lectures. The reprint consists of 59 pages, and can be obtained through any bookseller for one shilling.

R. B. (*Manchester*).—It is impossible to say whether the objectives you mention are worth purchasing or not, as all depends upon their age and aperture. The two-inch and one-inch would probably be safe enough, but the quarter-inch and one-twelfth-inch immersion lenses would require consideration. I should imagine that they are old lenses, and the improvement in lenses has been so great of recent years that it is not worth purchasing earlier lenses. Under any circumstances, external finish and condition are no guide to optical efficiency.

J. B. B. (*Torquay*).—This correspondent wishes to know how to clean the contents of the stomachs of fishes in order to obtain the diatoms frequently found in them, and would be glad of information on the subject, or references to books. I am sorry I cannot answer the question myself. Can any of my readers help, and, if so, will they write to me on the subject?

[Communications and inquiries on Microscopical matters should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Camberley. Correspondents are requested not to send specimens to be named.]

XUM

The Face of the Sky for August.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 4.25 and sets at 7.48; on the 31st he rises at 5.13 and sets at 6.48. Sunspots are not very numerous; small groups are occasionally visible on the solar disc.

The positions of the Sun's axis, centre of the disc, and heliographic longitude of the centre are given in the following table:—

Date.	Axis inclined from N. point.	Centre N. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
August 3 ..	11° 45′E	6° 1′	41° 42′
,, 8 ..	13° 40′E	6° 20′	335° 35′
,, 13 ..	15° 28′E	6° 37′	269° 29′
,, 18 ..	17° 10 E	6° 50′	203° 24′
,, 23 ..	18° 44′E	7° 1′	137° 20′
,, 28 ..	20° 11′E	7° 8′	71° 16′

THE MOON:—

Date.	Phases.	H. M.
Aug. 5 ..	☽ First Quarter	9 40 a m.
,, 12 ..	○ Full Moon	4 59 a.m.
,, 18 ..	☾ Last Quarter	9 26 p.m.
,, 26 ..	● New Moon	10 59 p.m.
Aug. 12..	Perigee	9 36 a m.
,, 26..	Apogee	6 18 a.m.

OCCULTATIONS.—The following occultations are visible from Greenwich before midnight:—

Date.	Star's Name.	Magnitude.	Disappearance.		Reappearance.	
			Mean Time.	Angle from N. point.	Mean Time.	Angle from N. point.
			p. m.		p. m.	
Aug. 3	80 Virginis	5.8	7.55	65°	8.38	347°
,, 8	4 Sagittarii	4.6	6.41	95°	7.54	286°
,, 11	ϕ Capricorni	5.5	8.12	157°	8.26	181°

THE PLANETS.—Mercury (Aug. 1, R.A. $7^h\ 30^m$; Dec. N. 21° 20′. Aug. 31, R.A. $11^h\ 16^m$; Dec. N. 5° 58′) is a morning star in Gemini at the beginning of the month rising about 3 a.m. The planet is in superior conjunction with the Sun on the 20th, hence he is unobservable during the middle and latter part of month.

Venus (Aug. 1, R.A. $6^h\ 24^m$; Dec. N. 17° 15′. Aug. 31, R.A. $7^h\ 35^m$; Dec. N. 17° 54′) is a morning star in Gemini, rising at 1.40 a.m. on the 11th, on which date she is at greatest brilliancy, thus forming a splendid object in the morning sky looking a little North of East. The diameter of the planet is about 35″ on the 15th, when 0·3 of the disc is illuminated.

Mars (Aug. 1, R.A. $9^h\ 13^m$; Dec. N. 17° 18′. Aug. 31, R.A. $10^h\ 27^m$; Dec. N. 10° 52′) sets about 20 minutes after the Sun on the 1st, and is in conjunction with the Sun on the 22nd, thus the planet is unobservable throughout the month.

Jupiter (Aug. 1, R.A. $9^h\ 34^m$; Dec. N. 15° 15′. Aug. 31, R.A. $10^h\ 0^m$; Dec. N. 13° 7′) is in conjunction with the Sun on the 17th, hence throughout the month the planet is lost in the Sun's rays.

Saturn (Aug. 1, R.A. $0^h\ 41^m$; Dec. N. 1° 42′. Aug. 31, R.A. $0^h\ 37^m$; Dec. N. 1° 7′) is describing a retrograde path in Pisces. The planet rises about 9 p.m. near the middle of the month and may be observed looking due East, situated several degrees below the great square of Pegasus; he appears as a bright star shining with a leaden hue. The ring appears more open than it will do for the remainder of the year, hence this is a favourable month for observation. About the middle of the month the ring appears inclined to our line of vision at an angle of nearly 8°, the southern surface being visible. The diameters of the outer major and minor axes are 44″ and 5″·8 respectively, whilst the polar diameter of the ball is 17″·6. The planet and ring system can be fairly well seen in small telescopes using a magnifying power of about 50.

Uranus (Aug. 15, R.A. $18^h\ 59^m$; Dec. S. 23° 11′) though somewhat low down in the sky, is well placed for observation during the early evening, the planet being due South on the 15th at 9.23 p.m. He is situated a little to the S.E. of the star ξ^2 Sagittarii. Uranus is just perceptible to the naked eye, but can easily be seen with a pair of opera glasses. The diameter of the disc is nearly 4″, and the colour is greenish. As seen in large telescopes the planet appears more luminous at the centre of the disc than at the limb—somewhat similar to Jupiter and Saturn.

Neptune (Aug. 15, R.A. $7^h\ 9^m$; Dec. N. 21° 44′) does not rise until after midnight. He is situated about half a degree South of the star δ Geminorum.

METEORS:—

Date.	Radiant. R.A.	Radiant. Dec.	——
	h. m.		
Aug. 10-12..	3 0	N. 57°	Great *Perseid* shower; radiant moving E.N.E. about 1° per day.
,, 15-25..	19 24	N. 60°	o Draconids; bright slow meteors.

Minima of Algol occur on the 1st at 11.28 p.m.; 4th at 8.17 p.m.; 22nd at 1.11 a.m., and 24th at 10 p.m.

TELESCOPIC OBJECTS:—

DOUBLE STARS.—Polaris, mags. 2·1, 9·5; separation 18″·6. The visibility of the small star is used as a test for a good 2-inch object glass.

σ Scorpii, R.A. $16^h\ 15^m$; S. 25° 22′; mags. 3·0, 7·6 separation 20″·6.

ζ Sagittae, R.A $19^h\ 45^m$; N. 18° 54′; mags. 5·7, 8·8; separation 9″·0; colours, white and blue.

α^1, α^2 Capricorni, R.A. $20^h\ 13^m$; S. 12° 50′; mags. α^1 4·5 α^2 3·8; naked eye double; separation 373″; very easy with opera glasses.

γ Delphini, R.A. $20^h\ 42^m$; N. 15° 46′; mags. 4·1, 5·0; separation 10″·8; very pretty double for small telescopes; colours, orange and light green.

NEBULA, &c.—Dumb Bell nebula in Vulpecula, nearly 4° due North of γ Sagittae. Rather faint object in a 3-inch telescope.

(M8) Cluster in Sagittarius; large luminous field of small stars; fine object in a pair of field glasses. About a degree E. of the star 4 Sagittarii.

CORRIGENDA.—Dr. G. H. Bryan wishes us to correct a slight error which occurred in his article on "The Index Method of Calculating Photographic Exposures" in our June number.

In Example 2, on page 130, the Sun's Altitude Index should read $3\frac{1}{2}$, Exposure Index $24\frac{1}{2}$, and required exposure 22 seconds.